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ENVIRONMENTAL QUALITY

H.R. 7796, H.R. 13211, H.R. 14605, H.R. 14627

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HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH, AND DEVELOPMENT

OF THE

COMMITTEE ON
SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

SECOND SESSION

JANUARY 17, 18, 19, 31; FEBRUARY 1, 2; MARCH 12, 13, 14, 1968

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ENVIRONMENTAL QUALITY

WEDNESDAY, JANUARY 17, 1968

House of Representatives,
Committee of Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to call, at 10:12 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order.

These hearings are a natural sequence to hearings this subcommittee held in 1966. We issued a report on those hearings entitled "Environmental Pollution, a Challenge to Science and Technology," which included a number of recommendations as to the whole question of pollution—air, water, and soil—and its attendant problems.

These hearings will explore the way in which the science resources available to the Federal Government are developed in support of our national goals for environmental quality. Goals and objectives have been spelled out in laws which have passed both Houses of Congress in recent years by overwhelming margins—often without a single dissenting vote. This legislation is a tribute to the leadership of Senators Ed Muskie and Jennings Randolph, Representatives Harley Staggers, Robert Jones, and John Blatnik; just to name only a few of many. The achievement of cleaner air and abundant water supplies depends to a very great extent on scientific research, engineering development, and techno-economic demonstration. But often we see these technical activities subjected to budget cutting and criticism, especially in this current period of fiscal constraint.

This subcommittee wishes to stress the crucial role for science and technology in pollution abatement. As a result of our hearings in 1966, which I have already referred to, we specifically identified two categories in environmental quality and waste management. First, there are problems of gross and obvious pollution where abatement technology is available and the only limitations on progress are the funds and time for construction of control facilities, and perhaps the will to put these to work. This category includes, for example, smoke and fly ash in the air and the treatment of sewage before release into surface waters. Certain regions of the country will have special problems which demand immediate solution. We have plenty to do in these catch-up abatement actions that need not wait for further R. & D. These steps can reverse presently increasing trends in certain pollutants and therefore lead by this method to immense improvements.

Second, some other important pollution problems are so complex that cause and affect relationships are not well worked out. Abatement technology may be costly and inefficient. Since our control efforts can be fully occupied on the gross and obvious problems, a time period for research is available to deal with these more important contaminants. Productive science and engineering in the next few years can give us a much improved control capability. Ingenious abatement methods can lower costs and ameliorate the change of habits and practices which improved environmental quality may require.

We should not, need not, and will not wait upon research to act where we recognize the problems and have feasible solutions. On the other hand, it would be wasteful of time and resources to pursue a crash program where quality deterioration is only vaguely established or where abatement costs probably outweigh benefits. A great deal of hard work is necessary to replace, therefore, conjecture an anecdote with practical control procedures.

Therefore, the current hearings are focused on the research programs of the Federal agencies which must produce an expanded basis of facts and technical options to make our pollution laws work. We believe the testimony will show that it is shortsighted indeed, to consider goals for restoring and maintaining the quality of the environment apart from the supporting research and development.

From our past hearings, a number of specific conclusions and recommendations were drawn. I would like to quote from our report, "Environmental Pollution—A Challenge to Science and Technology," a few items which pertain to the Federal research strategy:

> Federal Government scientific activities are not yet channeled to support announced goals in pollution abatement. There is no organization or coordinating group capable of systems analysis and broad management of Federal projects. Insufficient funding has made support of research spotty and disproportionate among problem areas. Agency missions may inhibit long term and comprehensive ecological studies. "Pollution" can cover an enormous variety of Federal agency programs ranging from water resources research to agricultural engineering. Limitations of definition will be necessary for effective program coordination.
>
> To improve our knowledge of what we are about, scientific activity in ecology and related fields should be immediately expanded to provide—
>
> (a) Baseline measurements in plant and animal communities and the environment—an ecological survey.
>
> (b) Continued monitoring of changes in the biosphere.

As an example, I would interject here that there have been alarming stories in the past few years that the accumulation of carbon dioxide in the atmosphere from fossil fuel combustion might cause a "greenhouse effect" and raise the temperature of the earth. Such a climate change would upset the world's weather, melt icecaps, and so forth. Last summer, HEW scientists reported that the mean annual world temperature actually was falling. The reason given (Science Vol. 156, p. 1358) was that particles in the atmosphere were increasing, thereby reflecting more sunlight and decreasing solar radiation reaching the ground. This may be a lesson for us that early impressions of environmental effects are often incomplete and that public statements should be tempered until adequate studies are completed.

> (c) Abilities to predict the consequences of man-made changes.
>
> (d) Early detection of such consequences.
>
> (e) Knowledge of the environmental determinants of disease.
>
> Ecological surveys and research should be centralized as to management in some one science-based Federal agency. The scientific activity should be performed (whether in Government laboratories or under contract by local

universities and research institutes) in geographical regions which correspond generally to natural environmental boundaries.

To place pollution abatement on a comparable basis with other national technology programs, systems analysis and management capability should be established within the Federal Government. This approach should be used along with the "planning, programming, budgeting" technique to organize both near and long-term Federal research and operational efforts in pollution abatement. More attention should be paid to interfaces between agency missions which make the management of environmental problems difficult.

We are pleased today to have as our first witness Dr. Donald Hornig, Director of the Office of Science and Technology in the Executive Office of the President. No person is better equipped than he to inform us of the status of Federal programs and to illuminate the very difficult tasks which the laws have given to the technical community. Dr. Hornig is, of course, a person very well known to this particular committee. We have listened to him in the past and always have learned a great deal from his testimony, and it is an association which we treasure. He is accompanied by his Assistant Director, Dr. Ivan L. Bennett, Jr.

(The biographies of Drs. Hornig and Bennett follow:)

DR. DONALD F. HORNIG

Dr. Donald F. Hornig was born in Milwaukee on March 17, 1920, the son of C. Arthur Hornig and the former Emma Knuth. In 1943 he married Lilli Schwenk and they have four children: Joanna, Ellen, Christopher and Leslie.

Dr. Hornig became Special Assistant to President Johnson for Science and Technology on January 24, 1964. He was simultaneously named by the President to be Chairman of the Federal Council for Science and Technology. On January 27, 1964, the Senate confirmed the President's nomination of Dr. Hornig as Director of the Office of Science and Technology in the Executive Office of the President. Dr. Hornig also serves as the Chairman of the President's Science Advisory Committee.

A graduate of Havard University, where he received his B. Sc. degree in 1940 and his Ph. D. in chemistry three years later, he was awarded a Guggenheim grant and a Fulbright scholarship for research at St. John's College, Oxford University, England in 1954–55, and in 1955 was appointed the first Bourke Overseas lecturer by the Faraday Society of London.

After receiving his doctorate at Harvard, Dr. Hornig spent a year as a Research Associate at the Woods Hole Oceanographic Institution in Massachusetts. From 1944 to 1946 he was a Group Leader at the Los Alamos Laboratory in New Mexico and in the latter years he joined the faculty at Brown University as assistant professor. Three years later he became an associate professor and Director of the Metcalf Research Laboratory. He was promoted to the rank of Professor in 1951 and the following year became Associate Dean of the Graduate School. Subsequently he was Acting Dean. In 1957 he joined the faculty of Princeton University and was appointed Chairman of the Department of Chemistry in 1958. Dr. Hornig was the first incumbent of the Donner Chair of Science at Princeton, established in 1958 by the Donner Foundation, Inc.

Dr. Hornig has been an associate editor of the *Journal of Chemical Physics* and a member of the Editorial Advisory Boards of *Spectrochimica Acta* and *Molecular Physics*. He was President, from 1945 to 1947, of Radiation Instruments Company, and served as Chairman of Project Metcalf of the Office of Naval Research in 1951–52. Before coming to Washington in 1964, he was a member of the Advisory Committee, Office of Scientific Research, U.S. Air Force. In 1959 he was appointed to the Space Science Board of the National Academy of Sciences, on which he served until February 1964. In 1960 President Eisenhower appointed Dr. Hornig to his Science Advisory Committee, and he was reappointed by President Kennedy in 1961. In late 1960 he served on the Kennedy Task Force on Space to help formulate policy in this field for the new administration.

In 1962–63 Dr. Hornig served as a member of the U.S. Delegation headed by Dr. Hugh Dryden which negotiated the agreement with the U.S.S.R. for cooperation in certain space activities.

Dr. Hornig was elected in 1954 to a three year term on the Executive Committee, Division of Physical and Inorganic Chemistry, American Chemical Society. He is also a Fellow of the American Physical Society (Member, Executive Committee, Division of Chemical Physics, and Chairman 1957–58); a Fellow of the American Academy of Arts and Sciences; a Fellow of the Faraday Society, London, and of the Washington Academy of Sciences in 1967. He was elected to the U.S. National Acadenmy of Sciences in 1957, and in 1964 he was named a member of the Board of Overseers of Harvard University. He was elected an Honorary Member of the Rumanian Academy of Sciences in February 1965. Dr. Hornig is a member of the American Philosophical Society (1967); in February 1967 was awarded the Engineering Centennial Award by PMC Colleges, Chester, Pennsylvania; and was the recipient of the 1967 Charles Lathrop Parsons Award of the American Chemical Society on November 30, 1967.

Dr. Hornig has published about seventy papers in the *Journal of Chemical Physics, Journal of the Optical Society of America. Journal of Physical Chemistry, Review of Scientific Instruments, Physics of Fluids, Molecular Physics, Spectrochimica Acta, Discussions of the Faraday Society*, etc. on molecular and crystal structure, infrared and Raman spectra, shock and detonation waves, relaxation phenomena and fast chemical reactions at high temperatures.

Dr. Hornig has been awarded honorary degrees by: Temple University (LLD 1964); Yeshiva University of New York (Doctor of Humane Letters 1965; University of Notre Dame (LLD 1965); Rensselaer Polytechnic Institute (Doctor of Science 1965; University of Maryland (Doctor of Science 1965); Ripon College (Doctor of Science 1966); Boston College (Doctor of Laws 1966); PMC Colleges (Doctor of Science 1967; University of Wisconsin-Milwaukee (Doctor of Science 1967); and Worcester Polytechnic Institute (Doctor of Engineering 1967).

Dr. Ivan L. Bennett, Jr.

Dr. Ivan L. Bennett, Jr. was born in Washington, D.C. on March 4, 1922. In 1944, he married Martha Rhodes of Atlanta, Georgia; they have four children: Susan, Paul, Katherine, and Jeffrey.

Dr. Bennett was nominated by President Johnson to be Deputy Director of the Office of Science and Technology in the Executive Office of the President on July 30, 1966 and the Senate confirmed the nomination on August 31, 1966.

After receiving his A.B. degree in 1943 and his M.D. in 1946, both from Emory University, Dr. Bennett continued his postgraduate and residency training in internal medicine at Emory, Johns Hopkins, and Duke; and was certified as a diplomate of the American Board of Internal Medicine in 1954. From 1947 to 1949, he was a guest investigator at the Naval Medical Research Institute in Bethesda.

After 2 years as Assistant Professor of Internal Medicine at Yale University, Dr. Bennett became Associate Professor of Medicine at Johns Hopkins in 1954 and, in 1957, he was made Professor of Medicine and Head of the Division of Biology and Oncology. In 1958 he became Baxley Professor of Pathology and Director of the Department of Pathology at Johns Hopkins University School of Medicine and Pathologist-in-Chief of the Johns Hopkins Hospital.

Dr. Bennett is a member of the editorial board of the *Bulletin of the Johns Hopkins Hospital, Experimental and Molecular Pathlogy, Laboratory Investigation*, and *Annual Review of Medicine*. He has been consultant to the Surgeon General of the Army, to the U.S. Public Health Service Communicable Disease Center. to the Office of Science and Technology, the Office of Emergency Planning, and to the Secretary of Health, Education, and Welfare. He was a member of the Commission on Epidemiological Survey of the Armed Forces Epidemiology Board from 1957 to 1966 and a member of the Pathology Training Committee of the National Institutes of Health in 1965–66. He has also served as Chairman of the Board of Scientific Councillors of the National Institute of Dental Research, Member of the Program-Project Committee of the National Institute for Allergy and Infectious Diseases, Chairman of the Pathology Test Committee of the National Board of Medical Examiners, and Member of the Committee on Influenza Research.

He is a member of the Board of Scientific Advisors of the Armed Forces Institute of Pathology, the National Board of Medical Examiners, and the Executive Committee of the Division of Medical Sciences of the National Research Council.

In April, 1966 he was appointed by President Johnson to the President's Science Advisory Committee.

Dr. Bennett has published about 120 scientific papers and is the editor of a textbook, "*Principles of Internal Medicine.*" He is a trustee of the Emory University Medical Alumni Association and is a member of several professional societies including the American Society for Clinical Investigaton and the Association of American Physicians.

STATEMENT OF DR. DONALD F. HORNIG, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY; ACCOMPANIED BY DR. IVAN L. BENNETT, JR., DEPUTY DIRECTOR

Dr. Hornig. Mr. Chairman and members of the subcommittee. It is a pleasure for me to respond to your request for an executive branch view of how Federal science resources can support the Nation's goals of improving environmental quality. In recent years, through legislation and new programs, a major new impetus has been given to improving the environment in which man lives, as you have indicated, both now and in the foreseeable future.

Now, to accomplish these ends research is needed in an extraordinarily diverse set of fields ranging from fuels and combustion technology to ecology, to epidemiological studies of health hazards, to studies of atmospheric circulation, to the disposal of radioactive wastes, and so on.

The principal immediate thrust is in the Federal Water Pollution Control Administration of the Department of Interior, the National Center for Air Pollution Control, the National Center for Urban and Industrial Waste, and the National Environmental Sciences Center, all in the Department of HEW, but major activities also going forward in Agriculture, in the Bureau of Mines, the Office of Coal Research, and various other bureaus of the Department of Interior; in the Atomic Energy Commission, the Environmental Sciences Services Administration of the Department of Commerce, the National Science Foundation which supports fundamental research, and in the near future HUD and the Department of Transportation will become increasingly involved. Now, what this reflects is that environmental considerations are involved in practically every activity of our society and our Government.

Environmental change, of course, is not a new phenomenon in our civilization. What is relatively new is the increasing scale, variety, and speed of the change which modern technology generates. The ever-increasing magnitude of the problems posed by air pollution, water pollution, and disposal of solid wastes has become a matter of national concern. In our attempts to cope with today's environmental problems, we have relearned what the ecologists have long known—that apparently isolated changes interact in unanticipated ways and that the eventual restoration of environmental quality will depend upon the solution of a series of interrelated problems, none of which can be understood in isolation from its fellows. We have also learned that though problems of environmental change are generated by technology, their solution cannot be viewed as a purely scientific or technological matter for there are important social, economic, and political factors to be weighed in deciding what actions to take.

It is in this overall context that I will address myself to the contributions which Federal science programs can make to improving the environment.

In my statement on January 7, 1966, to the House Committee on Government Operations, Subcommittee on Research and Technical Programs, I suggested a series of questions that need to be answered in determining the allocation of resources to programs involving research and development. What is the magnitude of the need and how important is it compared with other needs? What ideas are available on how to meet the need? I would like to emphasize that. Can the developments be applied in practice? Is society ready to assimilate and to pay for these results? In this area I should add another question, which is: What efforts are being undertaken outside the Federal Government, for instance in the private sector?

These questions must also be asked about research and development on environmental problems before deciding on the amount and character of research required in each area of environmental concern.

It is not enough to recognize the existence of a problem in general terms. Clearly, we know that the Los Angeles area is beset by "smog" and that most of our major streams are polluted by industrial effluents.

Only by detailed analysis of these general statements, however, can we determine those problems which can be solved now as opposed to those where the answer will require new knowledge and new technology.

As an illustration, the Department of Interior has been deeply involved during the past year in bringing together information in greater detail than ever before about the water pollution problem, including the location of pollution sources, types and characteristics of pollution, the magnitude of the problem in relation to population and industrial centers, States, river basins or subbasins; coastal areas, major lake areas, and other significant geographic characteristics.

From such information we can better determine—

> what we can do now with existing technology to gain the greatest results with available resources. This is the burden of our action program;
>
> what we can do with developing technology but which has to be tested before acceptance by the public to meet critical or future requirements. This represents our demonstration program;
>
> what we are not yet in a position to do. This will provide the basis for designing our research and development program through which we will seek the knowledge and techniques necessary to accomplish our future objectives.

If such analyses were available in detail we could answer the questions posed earlier in connection with determining the allocation of resources to programs of research, demonstration, and development in the general area of environmental quality. We can determine whether society is ready to assimilate—to accept, pay for, and use—the results of research.

In placing such emphasis upon detailed analysis of the problems of environmental pollution and their interaction, I do not mean to imply that we can or should wait until our understanding is complete before undertaking action. Rather, we should initiate action programs on the basis of the best information available, while continuing to add to our knowledge base so that action programs can be improved continually in the future.

With these matters in mind, my office has established, under the Federal Council for Science and Technology, a Committee on Environmental Quality to bring together, from across the entire Government, the information on policies, programs, and plans that will make it possible for use to establish our future activities on an increasingly more effective base.

This action is along the lines recommended by the committee report last year. It follows a pattern which has worked well in other areas. For example, the FCST established, some 4 years ago, a Committee on Water Resources Research. This committee has recommended a 10-year program for water resources research; it appraises new and developing needs in water resources, maintains an overview of the programs in all agencies of Government, and suggests periodic revisions in the Federal research program.

The decision to organize a Committee on Environmental Quality was made in April 1967, and the first meeting of agency representatives was convened on June 14, 1967. There have been 11 subsequent meetings.

Briefly, this committee has as its principal assignment the consideration of what science and technology can contribute to the vast variety of environmental problems, whether the various programs are adequate, how the programs relate to each other and to the activities in industry and the universities, and what more is needed. The group will assess current efforts, identify needs for changes, and develop ways to implement systematic programs in the area of environmental quality.

We have established a cooperative arrangement with the National Academy of Sciences and the National Academy of Engineering. On July 1, 1967, the chairman discussed the objectives of the FCST Committee in a meeting with the Academy Environmental Studies Board; a joint meeting was held October 1967 to coordinate future activities of the two organizations, and arrangements were made for the executive secretary of the Board to attend committee meetings as an observer, when it was appropriate.

In recent years there have appeared more than a dozen major reports on problems of pollution and environmental quality containing literally hundreds of major and minor recommendations. In order to gain a clear picture of what has emerged from all of these advisory groups, the committee has weighed the whole collection of recommendations and noted areas of consensus, instances of conflict, and some which are already being implemented. These recommendations can be roughly classified and analyzed into a number of areas: (a) Principles, policies, and goals; (b) administrative action, organization, and coordination; (c) research, development, and demonstration; (d) monitoring and surveillance; (e) information and education; (f) compliance (standards and enforcement); and (g) manpower and facilities.

The recommendations are being given very careful consideration, both from the standpoint of suggestions for implementation and as contributing factors to a review of current programs and an assessment of needs.

Mr. DADDARIO. In what way do you spell out instances of conflict? What do you mean by that?

Dr. **Hornig.** I do not think there is much overt conflict but I think there is considerable divergence among a number of the reports we have, in the relative degree of emphasis on various problems.

Mr. **Daddario.** You were referring only to conflicts of that kind?

Dr. **Hornig.** Yes. I am referring to conflicts in the assessment of what the problems, and the urgency of problems are, and what the nature of the problems is. You mentioned one, for example, in the CO_2 problem. The Tukey committee, for example, noted that at the present rate of burning fossil fuels we can expect our environmental carbon dioxide concentration to rise by 25 percent by the end of the century, and they raised very serious questions as to what the effect of that increase in carbon dioxide concentration would be since it would increase the absorption of solar energy.

Other people have pointed out that they did not adequately take into account the absorption of carbon dioxide by rocks as opposed to the oceans, that there were other factors which might go in the other direction, such as the increasing concentration of dust, ice crystals, and so on, in the atmosphere which would obscure solar radiation, and that we did not know enough, in any case, about the circulation pattern in the atmosphere to predict the consequences. So that this is one question, for instance, which needs to be resolved before we undertake any major programs. No one has any intention of shutting down the burning of oil and coal on account of that recommendation yet.

Mr. **Daddario.** I thought you might include under instances of conflict the problem that might arise from the number of agencies involved and the obvious conflict in bringing them all together and having them work smoothly in a coordinated way over the jurisdictional problems. You must run into this from time to time.

Dr. **Hornig.** Well, Mr. Chairman, this does pose problems, in fact sometimes very difficult ones. By and large, I think it is a sound way to do business because the fact is that this is not a homogeneous area. One should surely group, coordinate, and put under common leadership those things which can be pulled together into single programs, but I would not think it would make any sense, for example, to pull together under single leadership the studies on human health, where the expertise and knowledge is in the Department of HEW and NIH, and the problems of radioactive waste disposal, which are also potentially big environmental problems as we build a big nuclear power industry, where the expertise resides in the Atomic Energy Commission. I think it is quite proper that the central focus on these very divergent areas be separated, and the focus established where we have the essential competence and interest in the Government. I think what is important, however, is to maintain a good general overview of these very diverse activities.

Doing this for the President is the job of my office. The rather elaborate committee structure I am describing is how we are trying to see what the entirety consists of. As the work of the committee progresses I may have firmer views with regard to your question, because, as I said, this area spreads over so very many things. What you call environmental quality for one purpose may be connected with weather forecasting on the other. It is not clear at the moment what the best eventual division of effort will be.

Mr. **Daddario.** Mr. Fulton.

Mr. FULTON. Off the record.

(Discussion off the record.)

Mr. DADDARIO. Mr. Bell.

Mr. BELL. Mr. Chairman, while you were talking with the learned doctor I thought I might ask him this question. He was talking somewhat about the administrative problems, and the central focus and conflicts which might arise. I would infer from what he said that he would agree, would he not, that when States have an interest or a particular desire, such as the area of Los Angeles in California, to increase and to better their pollution battle a little bit beyond what the Federal Government wants, you would favor that, would you not, at least having the leeway to do so? There was an amendment which some of us know about called the Dingell amendment.

Mr. DADDARIO. I would say that that is a leading question, but you may answer it, Doctor.

Dr. HORNIG. I would like to see us maintain the highest possible standards of quality everywhere, not to have the lowest common denominator.

Mr. FULTON. Could you go a little further on that point? The question is whether the standards are high and being generalized, or whether should we take them on an instance-by-instance basis? What do you think? Should we be practical, do it that way, or leave our high standards nationally?

Dr. HORNIG. I think that question involves a lot of very complicated problems because when one talks of uniform standards, certainly the circumstances differ very widely from one area to another. On the other hand, if one has a widely fragmented set of standards, we fail to make use, for instance, of the total national market as an incentive to produce abatement devices. I think this is a question which requires very careful consideration.

Mr. DADDARIO. Mr. Bell.

Mr. BELL. I think you recognize there are many differences in States, such as the way the smog, or whatever the pollutant is, affects an area. It seems to me we should have the right to upgrade, to increase, to make better our pollution battle beyond what the Federal Government wants.

Mr. FULTON. Will you yield to me?

Mr. BELL. Yes.

Mr. FULTON. I think I disagree with you both because possibly it should be on a physical basis of pollution basins or environments, more or less unified, rather than either Federal or State. What do you think as to that?

Mr. DADDARIO. I can see no particular disagreement with what you have just said and what Dr. Hornig has been telling us.

As I understand the statement, he does believe the country is vast and that there are so many differences which exist. We have to recognize that you may need to establish different criteria in different places for certain purposes.

Mr. FULTON. I am talking as to standards. Maybe you might have to have three or four States together in a basin concept rather than to do it State by State.

Mr. DADDARIO. I would think that that would be implicit in what has been said. You should comment on that, however, Dr. Hornig.

Dr. HORNIG. I would say that surely political boundaries are not the natural boundaries for pollution problems.

Mr. FULTON. That is my point.

Mr. DADDARIO. Dr. Hornig, in the instances of conflict—and we need not get into it too deeply—during the course of our hearings it was spelled out that in the area of pollution there was an opportunity offered to our whole free enterprise system to involve itself. Through the development of competitive demands, goods would be produced which would be made available to the market. There would be a stimulus through our profit system which would help to bring the problem together once we were able to develop necessary techniques.

In the area of patents, these agencies which you talk about all take a different point of view even though there is a Government patent policy which does involve, as it should, and allow, as it should, a certain amount of discretion to the head of each agency. But the Department of Interior, as an example, is extremely rigid in this regard. You see here the possibility that one agency may not allow the free consumer system to operate as well as other agencies. This could be a serious area of conflict.

Dr. HORNIG. As you well know, Mr. Chairman, the question not only in this area but generally of how we should handle patents derived from Federal investments in research and development, has been a long and controversial one. At present it is pulled together by President Kennedy's patent policy of 1963. Now, there is a general principle which I think is, by and large, observed by the agencies. Just what is done, I might say, is affected by a wide variety of specific legislation affecting the agencies one at a time, which in part directs them to have different policies. So it has been very difficult to produce uniformity.

At any rate, where public money has been invested in producing a commercial product, and this applies to much of this area, in general the patent rights are not left with the performer, under the present policy. There has been some discussion as to whether in these cases where the Federal Government assumes the principal rights, whether in order to obtain commercial development exclusive licenses might be issued, but at the moment there is no policy in this regard.

Mr. DADDARIO. My question then comes down to this: Do you see this as falling within your phrase here of "instances of conflict"?

Dr. HORNIG. Oh, yes. I think that in this general area of the disposition of Government patents it surely was an instance of conflict, both among our agencies and within the Congress and the public.

Mr. DADDARIO. I understand that is so. I was trying to focus upon how it might affect the subject we are talking about because the record does appear to be clear. We are seeking ways and means to get more involvement here. It is, therefore, incumbent on us to look at those conflicts which might in fact deter and prevent the wider involvement of industry in the solution of this particular problem.

Dr. HORNIG. Yes. I would like to add that I consider this a central problem, since I think, and I believe you do, that much of the research, and particularly technological development, ought to be carried out by industry. There is a major question of how we provide suitable incentives in the private area to carry this out, and the patent policy is surely involved deeply in this question of incentives. There is by no means agreement on what kind of incentives are proper to both stimulate industry and protect the public interest.

Mr. DADDARIO. We need not go into this further at the moment, Dr. Hornig. We can look at other ways of stimulating activity. I brought it up only as one instance.

Mr. Fulton?

Mr. FULTON. Have you given any thought to my recommendation to have compacts within a particular pollution or drainage basin? Had you ever thought of compacts by States or regions, as we do on a Great Lakes compact or compacts for bridges? So far the discussion has been either the Federal Government might try to run it all, or a State by State basis, which to me is inadequate.

Could we set up some sort of regional commission that could handle these problems that run across State lines? Is this feasible?

Dr. HORNIG. I think the question of what the best relations are between the States, the Federal Government and the communities is going to take a lot of discussion.

I would not like to propose a simple solution. We have regional airsheds now. We have, for various purposes, evolved regional and basinwide commissions.

Mr. FULTON. May I give you an example?

Dr. HORNIG. I think the problem is to bring in local interests and still to make available, if you like, the large scale resources and inputs of the Federal Government into these efforts.

Mr. FULTON. We in Pittsburgh are in a tristate area, western Pennsylvania, eastern Ohio, and northern West Virginia. State and local handling is inadequate.

For example, I drove to Indianapolis not too long ago. We started at Cleveland with quite a heavy smog and it was clear at Pittsburgh, where we have smoke control. From Cleveland, Toledo, through Gary, Chicago, clear up to Indianapolis, there was a complete smoke pall. To talk about doing it by States or cities in that area is not feasible to me. What do we do about such a great problem?

Mr. DADDARIO. Dr. Hornig, I would like you to answer that question; but taking into consideration that you are to attend a Cabinet meeting this morning, would you let me know when you must leave? At that point, Dr. Bennett may take over for you.

Dr. HORNIG. I will be grateful if you will allow him to continue for me. The matter raised by Congressman Fulton is precisely what is involved in regional airsheds. Pollution does not know political boundaries. One has to look at the natural complexes of polluting sources.

Mr. FULTON. Would you have a method set up within Government to handle pollution sheds or basins?

Dr. HORNIG. This is provided to some extent in the Clean Air Act, as you know. This is still an evolving relationship.

Mr. FULTON. That is what I am getting at.

That is all, thank you.

Mr. DADDARIO. Will you continue as long as you can? We will try not to break in with further questions until you have to leave.

Dr. HORNIG. I have described the Committee on Environmental Quality under the Governmental Council on Environmental Quality. In order to deal with a wide variety of problems, three subcommittees were established to consider programs in their respective areas: (a) Subcommittee on Research, Development, and Demonstration; (b)

Subcommittee on Monitoring, Surveillance, and Compliance; and (e) Subcommittee on Information, Education, Manpower, and Facilities.

The development of recommendations involving principles, policies, goals, administrative action, organization, and coordination was reserved as a full committee function.

As a general comment, it is obvious that the entire area of pollution cannot be covered in a single study. Although initial broad summaries of the status of programs can be developed, the selection of specific study priorities and approaches within each of the subcommittees has been deliberately left flexible, because of the competence of the membership to judge where their efforts can be placed most productively.

The Subcommittee on Research, Development, and Demonstration is undertaking a review of ongoing programs to determine their nature, extent, and balance, and to assess relative priorities. It is concerned with (1) effects of pollution, (2) transportation, distribution, and degradation of pollutants, (3) measurement and instrumentation, (4) exposure to and sources of pollution, (5) research on social, economic, and legal aspects of pollution management, and (6) techniques of pollution abatement.

This all sounds very academic but within it are the kinds of questions we have asked this morning.

The monitoring and surveillance subpanel is presently assembling information from the agencies on (1) the nature, scope, and purpose of their programs, (2) the organization to accomplish these ends, and (3) estimated cost and man-year requirements of present and planned programs.

The Subcommittee on Information, Education, and Manpower is reviewing current Federal programs of education bearing on environmental quality. A jointly financed interagency analysis of national manpower needs for these purposes is being arranged.

Many people have recognized that in this whole area we are short in people who have any experience or expertise in pollution problems.

This study should lead to the development of a methodology for estimating manpower and education needs based upon tasks to be performed. Information programs also will be a focus of subcommittee endeavor.

Ad hoc groups have been formed to consider two additional problems. The first of these is a task force concerned with noise. Noise is a kind of pollution problem which we have just begun nationally to pay any attention to. This panel has received a briefing by the National Academy of Sciences Secretariat of the NAS–NRC Committee on Hearing, Bioacoustics, and Mechanics and is now reviewing Federal programs concerned with noise in the environment.

I might add there are not many. However, exhaustive consideration is being given to the aircraft noise problem specifically by a committee chaired by the Department of Transportation. My own Office has devoted considerable effort to the problem of aircraft noise in the vicinity of airports, but with the formation of the new Department of Transportation, we have turned this responsibility over to Secretary Boyd.

My Office had also been, as you know, concerned in the past year with the problem of sonic boom as a particular problem in aircraft noise and environmental perturbation, and that also is now the responsibility of Secretary Boyd, although we are still maintaining a general overview.

Mr. DADDARIO. The responsibility remains with you to see that this works out?

Dr. HORNIG. Our general responsibility to advise and assist the President on all major problems and programs with which he is concerned. But the principal responsibility will now be in Secretary Boyd's hands.

Going back to the committee, the second special group is a panel on systematics and taxonomy. The increasing attention being given to the ecological effects of man's activities calls for additional scientists capable of identifying the multiplicity of biological constituents of an ecosystem as a prerequisite to assessing changes. This group will study the demands of existing future programs for systematics and taxonomy.

The kind of problem with which you are well acquainted is the kind that is generated by the large-scale use of pesticides, which we need to do for agricultural purposes, but which we know to change the overall biological balance, but in fact in many cases we do not know what the longrun effects of changing that biological balance in nature may be.

Regular contact is being maintained with the National Committee for the International Biological Program since much of that committee's planning is dependent upon systematics.

Currently, the committee is preparing for its use a series of situation papers dealing with specific pollution-related topics. These papers will be used as a basis for establishing priorities for further committee actions.

I would emphasize that the Committee on Environmental Quality is an interagency group whose main role is one of technical coordination. We hope it can develop policy and program recommendations as well; but it should be clear that some problems cannot be tackled effectively through an interagency committee. Experience has shown that such problems as the selection of a lead agency or the establishment of a new activity are very difficult for an FCST committee.

The establishment of the group has precipitated an interesting and significant reaction.

On the mistaken assumption both within and outside Government that the FCST committee is a focal point for all environmental-quality related activities, inquiries have come in from public and private organizations, calling attention to problems, both old and new, that extend far beyond the committee's charter.

Mr. DADDARIO. Dr. Hornig, if it is not a focal point, where is the focal point? If there is not one, why should we not have one?

Dr. HORNIG. It is the best focal point we have. As I mentioned, many of the problems get way outside of the area of science and technology and research and development. It is not the focal point of all action programs. The focal point for the water pollution program is the Water Pollution Control Administration. The focal point for air pollution problems is HEW.

As I said, our role is to maintain a general overview for the President.

Mr. DADDARIO. But since all of these in some ways are connected, you really cannot separate them. In some way they do meld in one with the other. Doesn't there need to be, even though the operational responsibility may be in these agencies as you have spelled out, a way to figure out how they are interrelated? Doesn't there need to be a focal point? They cannot operate in isolation one from the other.

Dr. HORNIG. Within the general area of my responsibilities this is exactly what this committee and my Office is trying to provide. I am simply saying that there are a lot of problems that go beyond the scientific and the technical and the related ones.

Mr. FULTON. Even political.

Dr. HORNIG. Many of the problems are political. I think any focus that does not include the Congress would not make sense.

Mr. Chairman, may I be excused and allow Dr. Bennett to continue?

Mr. DADDARIO. Yes, Dr. Hornig. We would like to send some questions to you, or perhaps arrange for you to come back.

Dr. HORNIG. I would be very happy, if questions developed, to come back and talk further with the committee. I am very sorry to have this discussion cut off because I hoped to have a chance to talk further with you.

Mr. DADDARIO. We regret you are leaving.

Dr. HORNIG. The President has called a Cabinet meeting as you know, and I am not quite sure what the subject is.

Mr. DADDARIO. You better go and find out what it is about. Mr. Fulton would like to speed you off with a comment.

Mr. FULTON. We hope that this talk of economy will not give the impression that Congress does not back very strongly adequate research and development in many fields, including pollution. That is the first point. Second, on the chairman's statement, Senator Murphy, of California, and Senator Boggs, of Delaware; Mr. Bell, of California; and all the members of this subcommittee have certainly contributed to the legislation for cleaner air and cleaner water in this Congress. This cuts across party lines.

Dr. HORNIG. Mr. Congressman, I am pleased to hear these words, and I hope you speak for the majority.

Mr. DADDARIO. Dr. Hornig, I would amend Mr. Fulton's remarks by listing all Members of Congress.

Dr. Bennett, would you take up where Dr. Hornig has left off, please?

Dr. BENNETT. This situation has necessitated increased effort by the staff of OST and, in addition, the President's Science Advisory Committee plans to establish a continuing Panel on the Environment. This will provide a mechanism for utilizing the talent and interests of persons and groups outside the Federal Government for penetrating analysis and objective criticism and suggestion.

Mr. DADDARIO. When you say an increased effort, do you include an increased staff? Will you add people particularly qualified in this field?

Dr. BENNETT. This has involved the taking on of additional staff, although not into positions that were necessarily created specifically for that purpose. For example, Dr. Donald King who is here with us this morning has been devoting almost all of his efforts to this field since he came with the Office early last year.

Mr. Daddario. We will submit some further questions on that particular subject, because I think it is important that it be spelled out just how this activity is being performed and what your capability is manpowerwise to do it. You may continue.

Dr. Bennett. The Panel will have as its charter a mandate to maintain an overview of environmental problems and the steps being taken to solve them; to survey the direction and emphasis of current programs and assess their relative priorities; to identify problems receiving inadequate attention; and to keep the President advised on progress and opportunities. The Panel's scope of interest and responsibility will include pollution of air, water, soil, and the biota; the total earth environment; and resource conservation and exploitation.

As the members of this subcommittee so well know, the problems of environmental pollution are no respecters of national boundaries. They are worldwide. The recent report of the Department of Commerce Panel on Electrically Powered Vehicles, for example, emphasized the need and the opportunity for international cooperative programs on pollution abatement.

In this connection OST has taken the lead in assisting the State Department with plans for a Europe-wide meeting of environmental scientists next year to develop realistic collaborative programs in this area. This endeavor will emphasize technological advances in much the same fashion that the international biological program will stress basic scientific research.

Earlier, we made reference to the enormity and complexity of the problems of environmental change. It is predicted that our capability to produce electric power will triple by 1980, reaching 492 billion kilowatts with an output of 2.3 trillion kilowatt-hours. By 1975, it is expected that 105 billion gallons of gasoline will power the 130 million vehicles on our highways.

It is this sheer size and complexity that has led to the frequent suggestion that the use of systems analysis would help to clarify the problems we are facing and point the way to effective solutions. Such methods can be useful at various levels in the hierarchy of problems. For example, the disposal of solid wastes for a community, the abatement of pollution of a single stream, or the multiple problems of management of an entire river basin or airshed. OST has recently undertaken to clarify the benefits and limitations of this approach.

We are in the process of bringing together several of the Nation's foremost authorities in the physical and social sciences who are interested in the environment and understand the problems and techniques of managing large, interrelated regional systems.

We look forward to this effort as a means of moving the day closer when we can more effectively use our vast capabilities to gather, store, and use data; to bring this capability to bear in helping to develop more and improved alternatives to complex multivariable problems from which we can select appropriate responses to our growing environmental concerns.

We cannot delay action, of course, until we are able to lay down a massive, global strategy. We can, however, undertake action programs in the realization that their implications may be far reaching, and be prepared to modify and improve them as our basic understanding and analytical capabilities improve.

Finally, Mr. Chairman, I would like to address myself to the very difficult matter of the development of criteria and standards applicable to regulation.

As we have ventured into a more exact approach to these problems, we have come to realize the profound need for better physiological and toxicological data on the long-range effects of low doses of pollutants on man and other components of the environment. We have had forcibly brought home to us the fact that even the acute effects of most pollutants are so poorly characterized that criteria of health alone cannot be utilized in many cases to set precise limits and that a combination of the best available information, the best available opinion, a knowledge of what is technically possible and an understanding of the economic and social implications of regulatory actions are all required before action can be taken.

Mr. DADDARIO. Dr. Bennett, recently Dr. Lawrence E. Hinkle of Cornell University Medical College stated at a recent program in Congressman Ryan's district:

> At the present time I believe that there is no really clear cut evidence that pollutants, other than microbial agents, at the levels at which they occur ordinarily in the air or water in the U.S., are responsible for any significant amount of disease in our population

He goes on to say:

> We have every reason to believe that sooner or later some of these substances, alone or in combinations, may have profoundly bad effects upon the health of our population.

And finally he says:

> At the present time we have no good laboratory or experimental methods for detecting the pollutants in our environment that may be the most important causes of future ill health.

What are we doing to unravel this medical quandary as expresed in these typical statements from the profession? What do they add to in present Federal policy? How can we avoid vague fears of unscrupulous alarmists, and hasty inefficient action—in the absence of facts?

Dr. BENNETT. That is a rather all-encompassing question. I would like to say first——

Mr. DADDARIO. It is all encompassing but at the same time when we begin to discuss the question of criteria and health, and we put it in such vague terms—we slide all around the problem—the fact remains that there are conflicts. Because the question of health is so important, we should come to some definite understanding as to what the dangers to our health might be. Until we do, it seems to me to be quite difficult for us to develop the importance in comparison with other needs. Is society ready to assimilate and pay? How can we come to answers to these questions unless the people really know whether or not there is something to one side of this conflict or another? Do the pollutants in the air really affect our health or don't they? Some people say that the tendency could lead to an irreversible problem that once reached we could not possible overcome regardless of what we did. If that is so, shouldn't we be putting our efforts to it more than just assume, as we have now, that we should operate on vague generalities?

Dr. BENNETT. Mr. Daddario, let me say this: The problem is not that we lack evidence that some of these pollutants affect health. We are lacking evidence that they actually cause disease. There is abundant evidence that individuals already suffering from chronic disease have aggravated symptoms. There is abundant evidence that pollutants cut down on performance of otherwise healthy individuals. There is abundant evidence that they are harmful to certain plants. On the other hand, the area in which we are almost totally lacking in knowledge is what the effect will be of exposure to relatively low concentrations of materials over a period of 10, 20, or 30 years.

At the present time we have literally no way to extrapolate this. It is quite clear that if we are ever to have this information we must set up a mechanism for making these observations prospectively. In the meantime, lacking these observations and this information, we have to use criteria other than severe damage to health in trying to pick a number to set a standard. There are many other reasons for setting criteria. Eye irritation is perhaps a minor matter of health but it certainly is a major annoyance. We do have very good knowledge about certain of the effects of these pollutants on plants and physical structures. Therefore, since we lack quantitative health evidence, one can only say that our knowledge base should be expanded by setting up programs to get this information. At the present time, as I am sure will be brought out later on in these hearings, the responsible people in HEW are setting up such long-term programs.

Mr. **Bell.** Doctor, you spoke on page 10 of your prepared statement about systems analysis being used in this effort. Are you talking about the systems type of analysis that certain corporate enterprises are involved in? Is this the type of thing you are speaking of?

Dr. **Bennett.** Yes, sir.

Mr. **Bell.** Computer effort.

Dr. **Bennett.** It is the type of activity that has characterized several sectors of industry up until now.

Mr. **Bell.** As you know many of our governmental agencies make certain contracts with private industry today. Are you suggesting that maybe we change that and allow the systems type of analysis to be worked on in many instances by private organizations?

Dr. **Bennett.** I am unaware of the obstructions to which you refer.

Mr. **Bell.** There is some objection to many of our Government agencies making Federal contracts in this field with private corporations because it may give them a competitive advantage for later work. I am wondering if you would be in favor of this.

There is also the question of support service contracts in view of the recent rulings.

Mr. **Daddario.** If you have some problems with that, we could have Mr. Bell supply the question to you. You could supply the answer for the record.

Dr. **Bennett.** Yes, sir.

Mr. **Fulton.** If the gentleman will yield, my point is that when we are going into research, development, and effectuating programs to clean up the air, the water, and the environment, we must watch that we are not trying to change the commercial lines favoring one group over another. On page 10 of your statement there is an inference to me that you are saying that electrical-powered vehicles are better than oil- or gasoline-powered vehicles. From my point of view, it is no part of the jurisdiction of the Government to decide that either gasoline-, oil-powered vehicles, or electrical vehicles are better. For example, if the Government wishes to work with a particular industry on developing whether the pollutants must be removed from the fuel in the first place, during the burning, or in the exhaust or stack gases, that is a question within the industry.

I am afraid that the Government goes beyond its prerogatives when it tries to determine the direction of industries. That to me and my party should be a matter of private enterprise and of public acceptance and consumer demand. The Government should not try to say to a group of industries, you are not as good as the others. Therefore, you must change or give up your particular industry in the United States. When this happens, I think the Government is going too far. I agree with Dr. Santayana, the Spanish philosopher, formerly of Harvard and now deceased, when he said one of the things about the U.S. Government is that the Government is always trying to reform the people and the people are always trying to reform the Government, and luckily neither gets very far with the other. If we are going to have a change, we must be careful that we are operating within the lines that are set up by free enterprise, freedom of choice, and consumer demand. I think that is one of the great strengths of the U.S. system. We have this direction and judgments made by tens of millions. We do not have just one decision by the Federal Government. Would you comment on that?

Dr. BENNETT. With specific reference to what is on page 10 of the testimony, where we referred to the report of the Department of Commerce Panel on Electrically Powered Vehicles, in a sense, that is a misnomer for that Panel. I believe in these hearings later the deliberations of that Panel will be described, and they actually considered the possibilities for electrically powered vehicles and found that present technology is not favorable for this. A great deal of their report deals with possible improvements in the internal combustion engine. One of their points is that air pollution from internal combustion engines is a problem that is increasing at a more rapid rate in other countries than in the United States. For instance, in Japan and Western Europe, the increase in the number of vehicles since the war is such that they are experiencing a more rapid rate of increase in pollutants than we are in the United States.

Mr. FULTON. That is no reason the Government should adopt birth control programs for gas-powered vehicles.

Mr. DADDARIO. Dr. Bennett, I think Mr. Fulton's statement stands as a statement of philosophy and principle of his own.

Mr. FULTON. I wonder if you agree with it.

Mr. DADDARIO. I think you have gone as far as you need to answer it.

Dr. BENNETT. I would like to remove any implication, if I may, that the Office of Science and Technology favors electrically powered vehicles. I think there will be testimony concerning the Commerce report later in the hearings.

Mr. FULTON. Thank you.

Mr. DADDARIO. I would like to make the observation there is no interference which prevents industry from performing research activities of its own in this area. In most of the industries, which have an interest, there is research.

Dr. BENNETT. That is true.

Mr. **DADDARIO**. Is there a question, Mr. Ryan?

Mr. **RYAN**. I was simply going to state for the record that I am sure on this committee that there is basic disagreement, certainly on my part, with Mr. Fulton's stated philosophy. I would hope that the witness does not agree with Mr. Fulton's statement. I do not think we need to go into it further this morning except to make that clear. I think the Government has a clear responsibility in this area and the Government should set standards for pollutants. It is up to the industry to comply or not to comply, whereas it is up to the Government to show industry how to comply.

Mr. **DADDARIO**. I think Mr. Ryan's statement, as Mr. Fulton's, ought to stand on the record as their own particular statements. I do not believe that you as the witness, Dr. Bennett, need to qualify your remarks to either of them.

Mr. **FULTON**. But should he?

Mr. **DADDARIO**. May I ask you to proceed?

Dr. **BENNETT**. Perhaps the latter part of the statement will clarify the matter somewhat.

Decisions concerning sulfur oxide emissions exemplify this problem. Although the health effects of concentrations found in most localities are debatable, the irritation and annoyance are reasonably clear. Observations concerning the effects made under controlled circumstances in the laboratory may or may not be applicable under more complicated conditions when it is admixed with other atmospheric contaminants in the presence of smog, for example. Yet the standards adopted may have far-reaching effects upon energy policy and can affect a wide range of industries quite differently.

In some cases changing to fuel of low sulfur content may suffice. But since not enough low sulfur fuel is available in many regions, effective means of getting rid of the sulfur economically will be needed—and that is a technical problem. Whether it should be removed from the fuel, in the first place, or removed later during burning or from the stack gases, will depend on the processes developed. Moreover, the best process will not be the same in every circumstance. The problem appears to be the selection of the best and most efficient process in any given situation.

The Federal Government, through HEW and the Bureau of Mines, is financing research on these problems and a great deal is being done as well in industry laboratories with their own funds. The development of adequate incentives to private effort will clearly have to be a key part of our program and in the end the cooperation of everyone concerned will be necessary for success.

Mr. **DADDARIO**. Thank you, Dr. Bennett.

Mr. Roush?

Mr. **ROUSH**. I have no questions, Mr. Chairman.

Mr. **DADDARIO**. Mr. Bell?

Mr. **BELL**. Yes, Mr. Chairman.

You mentioned, Doctor, in Dr. Hornig's statement relative to the transportation problem that you still make an effort to study in the area of noise abatement? Is that correct?

Dr. **BENNETT**. While the Office of Science and Technology took the lead in the original study of the problem of noise from jet airplanes, that responsibility has now been transferred to the Secretary of Transportation, and there is a special committee giving continuing attention to that specific problem of noise chaired by the Department of Transportation.

Mr. **Bell.** I believe, as Dr. Hornig answered Mr. Daddario's question, the committee is still active in a study of this. Isn't that the answer he gave?

Dr. **Bennett.** A member of our staff sits in on the meetings of this committee, and its is part of Dr. Hornig's responsibility to keep abreast of that activity and to advise the President if and when the necessity arises.

Mr. **Daddario.** The operational activity is shifted, but the supervisory control remains with OST.

Mr. **Bell.** I was wondering if it would be appropriate for me to ask questions relative to that matter.

Dr. **Bennett.** It might clarify things if I pointed out that the original study was begun before there was a Department or Transportation.

Mr. **Daddario.** OST at the present time just has the responsibility of reporting to the President as to what activity is taking place in the Department of Transportation on this particular subject.

Dr. **Bennett.** That is correct, plus adding our own comments and recommendations.

Mr. **Bell.** I see.

Mr. Chairman, would it be appropriate for me to ask a couple of questions relative to this?

Mr. **Daddario.** You certainly may, Mr. Bell.

Mr. **Bell.** The International Airport of Los Angeles is partially in my district. This is quite a problem in noise abatement. Can you inform me as to any new development in this area? As I understand it, the power that an airplane has is really its lifeblood, and every attempt to control noise from a plane results in curbing power to some extent. Is this generally a true statement?

Dr. **Bennett.** In general this is the trade-off that one is faced with.

Mr. **Bell.** What is the direction in which you see the Department of Transportation going? Is it the direction of cutting the power to cut the noise, increasing the power and bringing the uplift higher and quicker, or a higher level at a quicker rate, thus causing less noise?

Dr. **Bennett.** I can answer only in a very general way, but I will be very glad to supply more specific information. Whatever is done will involve very long-term programs. The best answer at the present time, we believe, would be to relocate airports, but this is exceedingly difficult in terms of finding the proper territory to do it. It is a long-range thing. Even if it were possible, which it is, to design engines that make slightly less noise but produce essentially the same amount of power, one is faced with the economic problem of the replacement of all of the engines now in use, and it would probably be as long as a decade before that would be economically feasible. So that in the short term it appears to be a problem for which there is no good answer.

In the long term there are some possible answers, but whether they will be feasible is not simply a question of science and technology.

Mr. **Bell.** On changing the airport suggestion because of the supersonic planes, isn't this an implication that Howard Hughes has the right idea of establishing an airport in Nevada for Los Angeles?

Dr. Bennett. So far as the supersonic plane is concerned it will create no more disturbance than our present transports when it comes in and leaves the airport because at that time it will be traveling at subsonic speeds.

Mr. Fulton. If the gentleman will yield, I have the Greater Pittsburgh Airport in my district so we have the same problem.

I have made recommendations that nobody, but nobody will adopt. I believe the runways of planes should be put underground, and secondly——

Mr. Daddario. Will you send that down to the Secretary?

Mr. Fulton. I was in Navy Air in World War II and I know that the runways are used for taxiing and for revving up the engines. Why isn't that done underground? Then, when you come out, you are on an inclined slope and up and out you go.

The second point is this: I went out and saw the atomic cannon fired. I was amazed to hear that pine forests and young pine trees are the best absorption of sound in any kind of energy waves which go down and come up. Why don't we have the airports planted like a Christmas tree reservation. Trees could be planted on the side of the runways to absorb the sound. Smaller trees could be planted near the runways so that if the plane runs off there is no damage, and bigger trees outside. The trouble is when I use some imagination everybody snickers and laughs a little bit, but the alternative to moving the airport out of Los Angeles is to cut the sound and reduce the runway traffic. What do you say to that?

Dr. Bennett. I do not disagree. I would simply say again——

Mr. Fulton. You do not disagree?

Dr. Bennett. I do not disagree.

Mr. Fulton. I welcome you to the society.

Dr. Bennett. But I would say again that while these are partly matters of science and technology, the prime difficulty is that economic, social, and political factors create obstacles to the implementation of such ideas. That is really all I am saying.

Mr. Daddario. Which seriously is a real problem in this whole particular area.

Dr. Bennett. It is, yes.

Mr. Daddario. Mr. Brown.

Mr. Brown. I have no questions.

Mr. Daddario. Mr. Mosher?

Mr. Mosher. Can we get back briefly, Mr. Chairman, to Dr. Hornig's comment on page 9, which you have already discussed. The implication was that there are problems both old and new that extend far beyond the charter of the Committee on Environmental Quality. Is there an implication that there needs to be created some organ with a greater charter, some agency or group or committee with a larger charter? Or is the only organization available with a larger charter probably with Congress itself? Are these the problems that Dr. Hornig is referring to here which only the Congress can deal with? If that is the case, is the Committee on Environmental Quality preparing program suggestions for the Congress? Can we ultimately expect specific recommendations from this committee in these larger areas beyond the scope of any present interagency authority? For instance, the Congress created fairly recently the Presidential Commission on

Marine Sciences and Engineering, and really put on that Commission the job of very fundamental recommendations to Congress which we will be getting toward the end of this year in the Commission's report.

Can we expect that type of report ultimately from this Committee on Environmental Quality?

Dr. Bennett. Let me say I am quite sure the deliberations and analyses of this interagency committee will result in the identification of problem areas that will eventually be brought to Congress for action. However, at the present time, we do not feel a need for another study group. This area has been studied by many, many groups and the initial problem was to take the existing recommendations, to compare them with what is going on, and to see what additional authority might be needed and where additional research might be needed. The authority already exists for the Office of Science and Technology to be the focus for these activities.

You will recall that the President's Science Advisory Committee had a panel a few years ago that published a report, one of those which described the problems of restoring quality to the environment, but that panel then went out of existence. The recognition of the fact this is a continuing problem has led now to the decision to reestablish this panel on a continuing basis and not as an ad hoc group that makes recommendations and then disbands. Thus, there will be an arm into the agencies through the Federal Council Committee, there will be an arm to the outside public, to the private sector, through the activities of this PSAC panel and, as I have already indicated this has necessitated an increased effort in the Office of Science and Technology devoted to this broad area of environmental quality. So that we feel the authority exists and the creation of this Committee of the Federal Council for Science and Technology really triggered these other actions which are not surprising. I think there was a realization that something of this sort was needed, but the committee is what finally made things begin to move.

Mr. Mosher. Mr. Chairman, can we assume there will be a continuing and active liaison between this subcommittee and its staff and the Committee on Environmental Quality?

It seems to me there is a need for probably more communication than there has been in the past between this committee and the Congress.

Mr. Daddario. Mr. Mosher, there has been. Since we had our last hearings on the subject, we have continued such a relationship and it certainly is our intention that we will continue it. I think the question you ask is a very good one as to what recommendations we might expect from the activities that are going on under the aegis of OST. And I, too, think a corollary to that would be recommendations to be made as to how mechanisms can be developed within the executive branch so interagency problems can be adjusted.

I offhand would disagree with Dr. Hornig where he said in answer to one of my questions that the proliferation of activities going on in all of these agencies is the way in which to do it. I would think it ought to be more concentrated; perhaps not in one agency but certainly not spread around as much as it presently is.

I think the jurisdictional problems which exist with congressional committees and one thing and another must prevent us from homing in on the issues as they develop. I do think, Mr. Mosher, that the question you ask leads us to seriously keep involved in this over a period of time until we can see these things brought to a better understanding.

Mr. Ryan. Let me raise a question which was alluded to by Dr. Hornig and which you have discussed.

The public is more and more conscious of questions affecting the environment; first water and then air and now noise. This has become foremost in our thinking on questions of environmental pollution. I would wonder what role the Office of Science and Technology played, if any, in the decision to proceed with the SST, whether or not the question of sonic boom was studied by the Office of Science and Technology as it related to the development of the SST, and whether that was presented and really taken into consideration.

You spoke of the fact that as an SST comes into an airport, it will be traveling at subsonic speed, therefore the noise problem might not be any greater than the present jet traffic. However, it has been suggested by some that the sonic boom problem is such that the SST will not be able to fly overland either in the United States or Europe. If this is so, was this factor taken into consideration?

Where does the Office really affect the decisionmaking process in the Federal Government? Let's use the SST as an example.

Dr. Bennett. Mr. Ryan, I would be very glad to supply the answer to that but I really am unable to give a response off the top of my head. I will be glad to see to it that you receive an answer to your question. The sonic boom study was begun before I became associated with the Office. It had been almost completed. The responsibility has been transferred to the Department of Transportation, but I can get that information for you and I will be glad to make it a part of the record.

Mr. Daddario. Do you include in that, Mr. Ryan, the physiological and psychological effects on man?

Mr. Ryan. Yes; I do.

Mr. Daddario. Would you include that?

Dr. Bennett. Yes, indeed.

(The information may be found in the answer to question 19 appearing on page 37.)

Mr. Ryan. That raises the broader question—maybe you have some comment on it—what should the role of the Office of Science and Technology be in the decisionmaking process, whether it is constructing SST's or undertaking some other major problem?

Mr. Daddario. Can you supply that for the record?

Mr. Ryan. Unless you feel you can comment on it now.

Dr. Bennett. I can comment on that.

Our role is to obtain the scientific and technological information that enters into decisions of this type and to make appropriate recommendations. We are but one input into the decisionmaking apparatus and while we are free to express our opinion, and do so, there are many others, both within and without the Government, who are also free to express their opinions.

Mr. Ryan. I think that may be the problem. I think that is something this committee should really look at as we go along.

Mr. Daddario. Of course, we cannot impose on them the policy-making responsibilities which are those of the Executive, who acts on the recommendations given by the Committee, or perhaps the responsibility of the Congress.

Mr. Ryan. I am not suggesting that. I am suggesting there should be a greater ability to focus responsibility than there is.

Mr. Daddario. Yes; I understand. I just wanted to be sure we were not abrogating some of our own responsibilities in this area.

Mr. Ryan. No; I would never argue that we should.

Mr. Daddario. Mr. Lukens?

Mr. Lukens. No questions.

Mr. Daddario. Mr. Winn?

Mr. Winn. Thank you, no questions.

Mr. Daddario. Mr. Fulton?

Mr. Fulton. One of the questions Mr. Ryan brought up, I think, should be explored a little further. Should there be some sort of a relationship between the Office of Science and Technology with a group such as the National Space Council? Should you have that kind of a setup, using that simply as a form?

Dr. Bennett. I would say I see no need for any additional focus for this area within the Executive Office structure.

Mr. Fulton. So your Office would be a channel of information as the chairman has mentioned. The policy is set by members of the Cabinet and members in the particular field with a science and management capability through a separate council. That would be my suggestion. I hope you consider it.

That is all.

Mr. Daddario. Dr. Bennett, I appreciate your coming here today both to assist Dr. Hornig and acting as you have as a pinch-hitter for him. You have been extremely helpful.

We have a number questions which I hope we may submit for the record and which we will get to you as quickly as possible. Our staff will be in touch with you on that.

Dr. Bennett. Will that list of questions include the formulation of that posed by Mr. Ryan?

Mr. Daddario. We will put together both Mr. Bell's questions and Mr. Ryan's questions and they will be submitted as theirs to you.

Mr. Fulton. Could I congratulate you and Dr. Hornig on the excellent statement, and congratulate you also on your wisdom and your imagination.

Mr. Daddario. Mr. Fulton is happy you have joined him in a sort of committee of two.

Questions Submitted to Dr. Donald F. Hornig, Director, Office of Science and Technology.

Question 1. In your testimony you indicated that the role of OST is to "maintain a general overview for the President" regarding environmental quality. You indicated also that the main role of the Committee on Environmental Quality is "one of technical coordination" and that the focal point for water pollution problems is the Department of Interior and for air pollution the Department of Health, Education, and Welfare. In his testimony, Dr. Buckley indicated that the Committee's survey of what Federal agencies are doing in the pollution field was to make a solid base of information for any serious judgments concerning overlap, what areas are not covered, and whether the right programs and problems are being attacked.

Specifically, what is the role of OST in this regard? What can it do if it finds unnecessary overlap, that areas are not well covered, or that the priorities are not correct? Is this authority primarily one of persuasion rather than decision making?

Answer. As a member of the Executive Office of the President, OST is a staff office to the President. According to Reorganization Plan No. 2 of 1962, the Office is to . . . "assist the President in discharging the responsibility of the President for the proper coordination of Federal science and technology functions." More particularly, it is charged with advising and assisting the President with respect to: "Review, integration, and coordination of major Federal activities in science and technology. . ."

Its first role, therefore, is to understand, and to assist the agencies to understand, the program as a whole so that priorities, overlaps, and gaps can be identified. When a redefinition of roles and missions is called for, it can be formally effected through such mechanisms as a Bureau of the Budget circular. Presidential memorandum to the heads of the concerned agencies, or through an Executive Order. Most actions, however, are undertaken through discussion and persuasion, and this proves quite effective when the relevant facts are known and understood. Agreement achieved in this way can be formalized if necessary through a written interagency agreement. Finally, considerable leverage can be exercised through our role in the formulation of the President's budget each year.

Question 2. The FY 1969 budget notes "The obligations of the Coast Guard for the conduct of research and development will increase from $9 million in 1968 to $17 million in 1969. Major elements of this increase are research on the control of pollution by oil or other wastes and the development of buoy technology to collect oceanographic and environmental data." How is this coordinated between the Department of Transportation and the Department of the Interior?

Answer. The joint Interior-Transportation study on oil pollution revealed the need for considerable research on techniques for preventing spills, and for handling oil and other hazardous substances once they are on the water. During the course of this work, and also in the preparation of the Administration bill on oil pollution control, informal agreement has been reached by the Interior and Transportation Departments that the mechanical aspects of oil pollution control will be the subject of research by the Coast Guard, and the chemical aspects by the Interior Department.

Programs of the Federal Water Pollution Control Administration and the Coast Guard are being coordinated in detail through meetings between the two agencies.

Question 3. Agency cognizance in automobile air pollution would appear to include the Department of Health, Education, and Welfare for standards setting, the Department of Transportation for inspection and maintenance, the Department of Commerce for economic effects on industry and the Department of the Interior for fuels relationships. Has OST become involved in this or similar coordination problems? Please describe the procedures by which comprehensive Federal policy and practice can come about in such complex environmental quality issues.

Answer. The division of responsibility is correctly stated in the question, except that the Department of Transportation's responsibility for inspection and maintenance relates only to the certification that HEW grants for the development of State and local air pollution inspection programs are consistent with the highway safety program. An administration proposal to extend this requirement to the inspection and maintenance of air pollution controls was rejected by Congress.

In connection with automobile air pollution, the report prepared on this subject by a panel of the Commerce Technical Advisory Board was the result of a request from the Director of OST to the Department of Commerce to explore the implications of the 1965 PSAC report on environmental quality, with specific attention to this area.

With regard to a comprehensive Federal policy for environmental quality issues, I can prescribe no simple procedure for arriving at one. It involves the entire fabric of the economic, social and political system. The central problem is to understand what is involved in achieving a "livable environment," which costs are associated with steps to achieve it, what the ramifications of any steps proposed to improve it may be, and how the federal, state and local governments, as well as the private sector, can be organized to deal with it. This necessarily involves not only the Executive Office and the executive agencies, but the Congress and the public. A comprehensive public policy must evolve from both general and detailed analyses and studies, including both technical and policy studies, plus continuing discussion at all levels. OST plays a part in this through reports such as "Restoring the Quality of Our Environment," through the Federal Council Committee on the Quality of the Environment, the PSAC Panel on the environment, and through staff efforts.

OST is naturally involved in the coordination of these programs in which many agencies participate, although until now no serious coordination problems have arisen.

In a Memorandum of April 21, 1967, the President directed OST to provide advice on the allocation and use of research funds for the control of sulfur emissions, as well as on the appropriate research role of the various federal agencies.

OST is also involved through the direction by the President of January 30, 1967, that the Office "sponsor a thorough study of energy resources and engage the necessary staff to coordinate energy policy on a government-wide basis." Fuels are, of course, included in energy.

Question 4. "Liaison committees" proliferate in the environmental quality area. Please provide a complete list of these arrangements, their membership and scope of activity.

Answer. The following list identifies a number of the major groups concerned with the physical aspects of environmental quality. Also included are interagency agreements since much of the most significant coordination takes place via this mechanism rather than committees. In both instances, the lists may be incomplete because of (1) the difficulties in assembling detailed information over a short period of time, and (2) the deliberate omission of "environment related" arrangements or those of regional or local interest. Examples of the latter are the numerous groups concerned with the study or development of various rivers and/or river basins.

The list principally contains groups composed of representatives at the operating level directly concerned with continuing activities. No attempt was made to record the numerous informal arrangements concerned with problems of immediate or ad hoc interest.

The various Federal Councils with interest in the area such as the Federal Council for Science and Technology, the Federal Radiation Council, the Water Resources Council, The Marine Council and the President's Council on Recreation and Natural Beauty were omitted.

It is anticipated that as a Committee created by the Federal Council for Science and Technology develops, some of the previously established coordinating mechanisms may prove unnecessary.

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY INTERAGENCY COMMITTEES

1. Interdepartmental Committee for Atmospheric Sciences.

(a) Coordinate basic research activities in the atmospheric sciences.

(b) Commerce; Transportation; Agriculture; National Science Foundation; Atomic Energy Commission; Federal Communications Commission; Defense; National Aeronautics and Space Administration; State; Health, Education, and Welfare; Interior.

Observers: Office of Science and Technology, Bureau of the Budget, Commerce, National Academy of Sciences.

2. Committee on Environmental Quality.

(a) Identify and coordinate Federal programs concerned with pollution and other aspects of the environment.

(b) Office of Science and Technology; Commerce; Transportation; Interior; Atomic Energy Commission; Housing and Urban Development; Health, Education, and Welfare; Defense; National Science Foundation; Agriculture.

Observers: Smithsonian Institution, Council of Economic Advisers, Bureau of the Budget, National Aeronautics and Space Administration, Federal Power Commission, State.

3. Committee on Scientific and Technical Information.

(a) Establish liaison among the Federal agencies on information systems and develop programs to improve communication networks.

(b) Office of Science and Technology, Atomic Energy Commission, Defense, National Library of Medicine, National Aeronautics and Space Administration, Veterans Administration, State, Agriculture, Commerce, Interior.

Observers: General Services Administration; Transportation; Health, Education, and Welfare; Housing and Urban Development; Smithsonian Institution; Office of Emergency Planning; State; Post Office Department; U.S. Information Agency; Federal Communications Commission; Small Business Administration; Commerce; Central Intelligence Agency; Bureau of the Budget.

4. Committee on Solid Earth Sciences.

(a) Coordinate Federal activities and identify current and needed programs in this area.

(b) Interior, U.S. Geological Survey, Smithsonian Institution, National Science Foundation, Agriculture, Atomic Energy Commission, Defense, National Aeronautics and Space Administration, Housing and Urban Development, Commerce.

Observers: Office of Science and Technology, Bureau of the Budget, State, Arms Control and Disarmament Agency, Transportation.

5. Committee on Water Resources Research.

(a) Evaluate current efforts pertaining to water resources research and develop long-range plans for needed research.

(b) Office of Science and Technology; National Science Foundation; Interior; Tennessee Valley Authority; Transportation; Atomic Energy Commission; Defense; Water Resources Council; Health, Education, and Welfare; National Aeronautics and Space Administration; Agriculture; Housing and Urban Development; Commerce.

Observers: Council of Economic Advisers, Bureau of the Budget, State.

Other Interagency Groups.

6. Interagency Committee on Meteorological Services and Interagency Committee on Applied Meteorological Research.

(a) Assist the Office of the Federal Coordinator for Meterological Services and Supporting Research (Commerce) in the preparation of plans.

(b) Agriculture; Commerce; Health, Education, and Welfare; National Science Foundation; Atomic Energy Commission; Defense; National Aeronautics and Space Administration; State.

Observer: Interior.

7. Federal Committee on Pest Control.

(a) Provide advice to the Secretary of Agriculture and the Food and Drug Administration on pesticide use.

(b) Agriculture; Health, Education, and Welfare; Interior; Defense.

Observers: State; Housing and Urban Development; National Science Foundation.

8. Armed Forces Pest Control Board.

(a) Coordinate Defense pest control programs.

(b) Defense; Health, Education, and Welfare; Interior; Agriculture.

9. Interagency Aircraft Noise Abatement Advisory Committee.

(a) Coordinate development of satisfactory solutions to the aircraft noise and sonic boom problems.

(b) Transportation; Housing and Urban Development; Agriculture; Defense; Health, Education, and Welfare; National Aeronautics and Space Administration; Office of Science and Technology.

10. Federal Advisory Committee on Water Data.

(a) Plan and carry out a program of data acquisition and to store and make available the data obtained.

(b) Housing and Urban Development; Federal Power Commission; Agriculture; Commerce; Atomic Energy Commission; Defense; Health, Education, and Welfare; Tennessee Valley Authority.

11. Interagency Committee on Coordination of Sewer and Water Programs.

(a) Develop procedure to facilitate administration of water and sewer programs.

(b) Bureau of the Budget, Commerce, Interior, Agriculture, Housing and Urban Development.

12. Steering Committee—U.S.-German Cooperative Program in Natural Resources, Pollution Control and Urban Development.

(a) Joint study in air pollution, solid waste, water pollution, coal research, noise abatement, electric power, and urban planning.

(b) Interior; State; Housing and Urban Development; Health, Education, and Welfare.

13. Land Use Under Open Space and Outdoor Recreation Programs.

(a) To coordinate the planning and acquisition of land under the Outdoor Recreation Program.

(b) Housing and Urban Development and Interior.

14. Coordinating Urban Planning Assistance with Soil Conservation Services.

(a) To set forth requirements for coordinating land use planning under 701 with Resources Conservation and Development Projects.

(b) Housing and Urban Development and Agriculture.

15. Advances for Public Works Planning.

(a) To notify and consult with other agencies on applications for public works planning advances, where the planned projects are of interest to those agencies.

(b) Department of Transportation; Health, Education, and Welfare; Commerce; Agriculture; Housing and Urban Development.

16. Agreement Between United States Department of Agriculture and Housing and Urban Development on Assistance to Small Communities for Water and Sewer Facilities.

(a) To make determinations regarding jurisdiction over sewer and water grants in towns under 5,500 population.

(b) Agriculture and Housing and Urban Development.

17. Planning in Bureau of Land Management Areas.

(a) When an application for a planning grant is contemplated and BLM lands are situated within or adjacent to the planning area, the BLM State Office is invited by the State planning agency to coordinate its multiple-use management and disposition programs with the 701 planning program.

(b) Interior and Housing and Urban Development.

18. Relating Airport Location and Expansion to Comprehensive Planning.

(a) The FAA is notified of a locality seeking 701 assistance so that an airport interest in the area may be related to comprehensive planning.

(b) Transportation and Housing and Urban Development.

19. Coordination of Site Selection for Roads and Public Housing.

(a) To avoid possible conflicts over sites selected for public housing units and those planned for highways.

(b) Transportation and Housing and Urban Development.

20. HUD-HEW "Umbrella Agreement."

(a) To provide for coordination and cooperation between HUD's 701 comprehensive planning and HEW's comprehensive health planning where interests or responsibilities are shared.

(b) Health, Education, and Welfare and Housing and Urban Development.

21. Flooding Potential in Urban Areas.

(a) To provide for receipt from Corps of Engineers of flood plain studies.

(b) Defense, Housing and Urban Development.

22. Cooperating in Research, Administration, and Management of Fish and Wildlife Resources on Forest Service Land.

(a) Reciprocal advisory agreement in Forest Service lands and fish hatchery operation.

(b) Interior and Agriculture.

23. Effects of Dredging, Filling and Excavating on Fish and Wildlife and Water Pollution.

(a) Defense notifies Interior of anticipated activities and consults on potential consequences.

(b) Defense and Interior.

24. Licensing and Regulation of Proposed Nuclear Installations.

(a) Interior advises the Atomic Energy Commission on new nuclear installations.

(b) Interior, Atomic Energy Commission.

25. Recreation Use for Hydroelectric Projects.

(a) Interior provides advice on recreation use plans for projects subject to licensing by the Federal Power Commission.

(b) Interior, Federal Power Commission.

26. Research and Development Contract on Packaged Boilers.

(a) Systems, concepts, and evaluation of packaged boilers burning coal will include air pollution analyses for Health, Education, and Welfare.

(b) Interior; Health, Education, and Welfare.

Question 5. In your testimony you indicated that OST advises the Bureau of the Budget regarding environmental quality. What types of advice are given? Is it primarily regarding the technical content of agency programs or does it also include advice as to overall priorities as evidenced by their budget allocations?

Answer. This advice includes priorities among program areas, the technical content of agency programs, program priorities in the areas of research, development, and demonstration, advice about budgetary estimates in relation to priorities, advice concerning expansion of inadequately funded programs where authority exists, and advice concerning revision of allocations where estimates are not commensurate with the nature or priority of a task.

The efficacy of any advice is limited by the legislative history of many of these programs and the many Committee jurisdictions involved.

Question 6. How many people are there on the staff of OST or the Federal Council working in the area of environmental quality? What does the effort represent in terms of man years? What activities do they perform?

Answer. There are currently 6 members of the professional staff of OST (out of a total of 19) who devote a significant portion of their time to environmental quality activities. Their combined efforts in this area, strictly defined, represent the equivalent of two to two and one-half man years.

Activities include (1) overall program organization and coordination, (2) staff studies on specific problems such as environmental health and general programs related to environmental quality such as energy policy (3) participation on departmental and interdepartmental panels (4) chairing FCST interdepartmental committees on water resources and environmental quality (5) working with the Budget Bureau on technical and managerial questions (6) responses to inquiries from Congress, public agents, industry, universities, professional societies, and individuals (7) evaluation of reports in the area and proposing means for implementing desirable recommendations (8) organizing the new PSAC continuing Panel on the Environment (9) maintaining liaison with the National Academy of Sciences and Engineering, and (10) provision of advice to the President on related policy issues.

As public interests and commitments in environmental quality have increased, the need for greater staff strength has become apparent. Accordingly, another full-time senior staff member will be added to the Office on April 21, 1968, and one additional full-time professional position has been requested in the 1969 budget. Filling this position should permit OST to imporve its capabilities for discharging its increasing responsibilities in environmental quality.

Question 7. Do you view the Councils such as those proposed by Mr. Dingell (H.R. 7796) or Mr. Tunney (H.R. 13211) a constructive addition to the decision-making process regarding the whole question of environmental quality or are such functions adequately provided by OST and the Federal Council?

Answer. We are preparing reports on H.R. 7796 and H.R. 13211 which will be submitted to Bureau of the Budget for clearance along with reports of other agencies.

Question 8. Concerning the Survey of Federal Expenditures for Pollution Research and Development, please supply a table of expenditures by agency and activity for the current fiscal year.

Answer. A copy of the requested information is attached. Details are included in 1967 and 1968 expenditures.

TABLE 1.—EXPENDITURES REPORTED BY THE FEDERAL GOVERNMENT ON POLLUTION RESEARCH, DEVELOPMENT, AND DEMONSTRATION (EXCEPT PESTICIDES) IN FISCAL YEAR 1968

[Thousands of dollars]

	Fiscal year 1967				Fiscal year 1968		
	Including pesticides	Excluding pesticides			Excluding pesticides		
	Total	Intramural	Extramural	Total	Intramural	Extramural	Total
1. Effects of pollution	44,258	12,891	22,152	35,764	16,294	25,188	41,943
(a) Directly on man	17,508	6,463	6,123	12,645	8,960	5,601	14,632
(b) On crop plants and domestic animals	5,234	753	2,731	3,484	1,418	2,617	4,035
(c) On nondomesticated plants and animals	9,256	2,200	4,513	7,375	2,324	4,745	7,459
(d) On laboratory animals	6,289	....	6,289	6,289	....	6,808	6,808
(e) On materials or structures	414	249	165	414	304	229	533
(f) On environments	(5,481)	(3,201)	(2,280)	(5,481)	(3,263)	(4,982)	(8,245)
(1) Air	736	352	384	736	302	242	544
(2) Freshwater (eutrophication)	1,742	1,101	641	1,742	960	1,603	2,563
(3) Marine	873	683	190	873	701	320	1,021
(4) Urban	155	....	155	155	50	1,076	1,126
(5) Rural	1,050	1,000	50	1,050	1,150	453	1,603
(6) Wild	....	....	....	....	....	....	....
(7) Soils	65	65	....	65	65	....	65
(8) Mixed	202	....	202	202	....	598	598
2. Transport, distribution, and fate of pollutants	29,586	5,247	12,941	18,602	5,830	13,003	19,090
(a) Movement	16,002	4,571	11,431	16,002	4,884	10,996	15,880
(b) Degradation	2,186	676	1,510	2,186	946	2,007	2,953
3. Measurement and instrumentation	14,736	6,836	4,083	11,536	7,090	4,296	12,042
4. Exposure to and sources of pollution	2,403	1,782	621	2,403	2,341	747	3,088
5. Social, economic, and legal aspects of pollution	1,891	319	1,572	1,891	684	2,022	2,706
6. Prevention and control of pollution	118,967	25,832	49,826	75,779	31,142	74,414	105,666
(a) Research	66,195	13,171	17,153	30,445	16,782	18,612	35,504
(b) Development	29,272	2,951	18,883	21,834	3,812	30,709	34,521
(c) Demonstration	23,500	9,710	13,790	23,500	10,548	25,093	35,641
Total obligations	211,841	52,907	91,195	145,975	63,381	119,670	184,535

Note: Fiscal year totals and numbered category totals may exceed the sums of the respective rows and columns because some agencies did not provide detailed breakdowns. Research and development estimated at $132,600,000 in fiscal year 1967 and $136,500,000 in fiscal year 1968 not conducted for pollution-related purposes also contributes to understanding and controlling pollution. $9,000,000 of this in fiscal year 1967 and $10,000,000 in fiscal year 1968 was spent on aircraft noise.

TABLE 2.—*Pesticides research conducted or supported by the Federal Government*[1] *in fiscal year 1967. Data gathered and supported by the Federal Committee on Pest Control (FCPC)*

	Expenditures (thousands)
1. Effects of pollution[2]	$8,494.6
(*a*) Directly on man	4,862.9
(*b*) On crop plants and domestic animals	1,750.4
(*c*) On nondomesticated plants and animals	1,881.3
(*d*) On materials or structures	
(*e*) On environments:	
(1) Air	
(2) Freshwater (eutrophication)	
(3) Marine	
(4) Urban	
(5) Rural	
(6) Wild	
2. Transport, distribution,[3] and fate of pollutants	10,985.2
(*a*) Movement	
(*b*) Degradation	
3. Measurement and[4] instrumentation	3,200.4
4. Exposure to and sources of pollution	
5. Social, economic, and legal aspects of pollution	
6. Prevention and control[5] of pollution	43,188.5
(*a*) Research	
(*b*) Development	
(*c*) Demonstration	
Total obligations	65,868.7

[1] Includes data from Department of Agriculture; Defense; Health Education, and Welfare; Interior; Atomic Energy Commission; National Science Foundation; and the Tennessee Valley Authority.

[2] Included as categories B–3 and D on the FCPC questionnaire.

[3] Included as category E–1 on the FCPC questionnaire.

[4] Included as category F on the FCPC questionnaire.

[5] Included as categories C1–11 and E–2 on the FCPC questionnaire.

TABLE 3.—TOTAL ESTIMATED EXPENDITURES BY AGENCY ON POLLUTION RESEARCH, DEVELOPMENT, AND DEMONSTRATION

Agency	Total by agency, fiscal year 1967			Fiscal year 1968 excluding pesticides
	Pesticides	Other than pesticides	Total	
Agriculture	45,966	9,303	55,269	10,203
Commerce		1,243	1,243	1,288
Defense	622	1,873	2,495	1,484
HEW	13,794	44,917	58,711	54,692
HUD		124	124	
Interior	4,053	57,460	61,513	83,802
State	478		478	
Transportation		305	305	766
AEC	412	30,187	30,599	31,441
NASA		80	80	200
NSF	493		493	
TVA	48	483	531	659
Total	65,866	145,975	211,841	184,535

Question 9. What is the plan to use this data as a management tool?

Answer. The budgetary analysis will be used to identify existing programs. Particular attention will be given to the balance among programs, to coordination of activities and to areas which might require additional effort. Assessments and recommendations of the Committee will be submitted to FCST and OST. Following approval, the information will be used by the agencies in developing their programs, by OST in advising the President on Policy issues and in consulting with the Bureau of the Budget. It will, of course, be available to the Congress in assessing the overall program and its balance.

Question 10. Will you designate additional lead agencies? Are the data good enough to compare relative emphasis or priorities?

Answer. It is not possible to say at this time whether lead agencies will be designated, other than those already given clear authority by the Congress. In general, the designation of lead agencies has not been particularly successful except when, as in meteorological services, a single agency is clearly dominant.

Emphasis and priorities do not derive from data in any mechanical way, but must be based on analysis of many factors plus good judgment. A great deal more data are needed to make sound analyses and judgments.

Question 11. Have any steps been taken to implement recommendations of this Subcommittee in October 1966 "toward establishing systems analysis and management capability within the Federal Government"? Please describe.

Answer. Steps have been taken to implement the Subcommittee's recommendation in environmental fields such as water and air pollution and solid waste disposal. In water pollution research, substantial steps are being made in developing "P–P–B" analysis. In addition, the testimony presented by Assistant Commissioner Leon Weinberger before the Subcommittee on January 31, indicates a systematic evaluation of research problems and programs underway by his agency.

Within HEW, air pollution and solid waste disposal programs are both undertaking activities that will lead to increased utilization of program analysis and development in a "systems" sense (see also Answer to Question No. 20).

Question 12. Concerning "health" vs. "resource" concepts for environmental quality: The Department of the Interior seems to be emerging as the champion of environmental quality. Could you discuss the pros and cons of recognizing one agency as an "assessment function" for all Federal activities which affect environmental quality?

Answer. OST regards the "health vs. resource concepts for environmental quality" as an artificial dichotomy based upon traditional missions of Departments. The Department of Interior is not, in our view, any more the champion of environmental quality than is the Department of Health, Education, and Welfare or the Department of Housing and Urban Development.

There are numerous, legitimate reasons for preventing pollution ranging from those which pertain directly to health such as purifying drinking water to those associated with other values, such as wildlife preservation or the beauty of a landscape. One of the most difficult tasks ahead will be deciding on the relative values we are willing to assign to various aspects of environmental quality as a basis for subsequent action.

Economic or cost-benefit analysis in the areas of mineral, forest, or fuel resources are quantifiable. In contrast, specific indicators for aesthetics, health, and preservation of animal and plant species are less easily quantified but not necessarily less important as components of "quality" in the environment.

The assignment of an "assessment function" to a single agency would imply self-assessment if the agency had program reponsibility. It would also imply the assessment of the programs of one agency by another peer agency. In the past this concept has proved unsatisfactory or even unworkable.

To place our national program in context, it is necessary to emphasize that the United States economy is product-market oriented. In response to this fact, we have developed a Federal science structure which provides a capability for responding to specific segments of the economy. This arrangement prescribes that agency responsibilities should extend through a continuum from research, through intermediate activities to action programs. This facilitates the smooth flow of research discoveries into programs which can exploit and utilize them. The advantages of such a system are obvious.

Wastes are produced or spun off in the course of the production process and can be treated in this context. Presumably the abatement of these waste problems rests in examining, in their entirety, specific production-marketing processes to determine the points at which established controls may be applied most successfully and economically. This approach associates environmental quality responsibilities with agency missions, and recognizes that specific segment of the economy may be both sinners and sinned against. Calling attention to cases of the latter, particularly, is a responsibility we all share. It affords a useful device for insuring the recognition of broad problems. Efforts by one agency to assess the efforts of other agencies at the same level in the government often are not successful.

Question 13. Secretary Gardner has stated regarding Federal leadership in environmental quality: "We believe such leadership should come from a department or agency whose fundamental responsibilities are fully consistent with the central purpose of controlling air pollution and improving the management of solid waste problems—and that purpose is to protect the public health and welfare." What is the rationale for water quality in which water pollution control is separated from health relationships and placed in the Department of the Interior?

Answer. This question was largely answered in the preceding statement. A number of water quality problems are of a "resource" nature. The Department of Health, Education, and Welfare has responsibility for health aspects of water quality. The transfer of the authority for general control of water pollution from HEW to Interior was based upon judgments that the general problem was one of conservation of resources rather than "health and welfare," and that the water quality control program must be integrated with overall water and related land resources planning and development.

Question 14. Do you believe that the public health impacts of air and water contaminants will be dfined adequately to provide motivation for environmental improvement? Please explain.

Answer. Where environmental contaminants have public health impacts, they should most assuredly be the principle consideration in motivating improvements. The definition of the effects on human health is a difficult problem. This point is further discussed under Question 16. As mentioned previously, however, there are other values which must be considered in environmental quality. Levels of contamination for which no adverse effects on health can be demonstrated may be undesirable for aesthetic or other reasons. This would necessitate establishing standards which are unreleated to health.

At any rate, there are ample reasons for not delaying action until the exact qualification of effects on human health has been accomplished.

Question 15. What is the basis of national policy for the environment—human health and welfare or resource management?

Answer. This point was discussed under Question 12, and amplified in the responses to Questions 13 and 14.

Question 16. Dr. Bennett stated "we are almost totally lacking in knowledge on what the effect will be of exposure to relatively low concentrations of pollutants over a period of 10, 20, or 30 years." When do you estimate that we will have such knowledge and what will it cost to obtain it? When do you estimate that HEW will have sufficient knowledge to issue reliable criteria for such low concentrations?

Answer. Many of the pollutants with which we are concerned currently have been in our environment for long periods of time; for example, those resulting from various combustion processes. However, with accelerated industrialization and increased population density these problems have been aggravated. Other contaminants have been introduced into our environment comparatively recently, and their long-term effects have not yet been established. In short, the majority of our pollution problems have been of comparatively recent concern. It will be a long time before reliable information on long-term effects is available.

Synthetic organic pesticides are a case in point. Their use became widespread in the late 1940's and 1950's. A significant concern for the hazards, the persistent chemicals presented was expressed in the 1950's culminating in the publication of "Silent Spring." Although monitoring of man, his food supply and various components of his environment indicate there are no short-term effects, the question still remains of long-term hazards which have not yet been expressed. For example, there are illustrations that these materials accumulate in food chains.

Improved usage techniques have been developed as well as substitute materials which can be used for many pest control problems.

Experimentation and observation will be required perhaps indefinitely to condemn or exonerate specific pollutants suspected of causing chronic harm, if there are no indications of short-term hazards. The principal question rests in how many years or generations must pass before we will be convinced that a particular contaminant is not injurious. In addition, new materials are constantly being introduced into the environment which will require similar vigilance. In view of these facts, it is impossible to estimate with any certainty either the time span or cost required to be positively certain of the concentration levels which will not adversely affect our environment. However, large volumes of information are being accumulated and, when a significant body of information is available, informed judgments are made and standards established with a considerable margin of safety. As additional information is accumulated, standards may be lowered or raised.

Our alternative is to wait until experimentation convinces us beyond a doubt that no harmful effects to the environment will result from the introduction of a new factor into it. As mentioned previously this may require generations to demonstrate. The net effort would be a moratorium on the application of science and technology.

Question 17. What role does OST play in assessing the economic considerations inherent in setting air and water criteria or standards such as the cost of compliance versus the overall benefit, and the effect it will have on the competitive position of various industries within the economy and the total scheme of things? IF OST does not do it, whose responsibility is it?

Answer. Section 305(a) of the Clean Air Act as amended assigns responsibility for economic studies of air pollution to the Secretary of the Department of Health, Education, and Welfare.

"In order to provide the basis for evaluating programs authorized by this Act and the development of new programs and to furnish the Congress with the information necessary for authorization of appropriations by fiscal years beginning after June 30, 1969, the Secretary, in cooperation with state, interstate, and local air pollution control agencies, shall make a detailed estimate of the cost of carrying out the provisions of this Act; a comprehensive study of the cost of program implementation by affected units of government; and a comprehensive study of the economic impact of air quality standards on the Nation's industries, communities, and other contributing sources of pollution, including an analysis of the national requirements for and the cost of controlling emissions to attain such standards of air quality as may be established pursuant to this Act or applicable State law."

Sections 16(a) and 18 of the Federal Water Pollution Control Act as amended vests similar authority in the Secretary of the Interior.

Section 16(a): In order to provide the basis for evaluating programs authorizing by this Act, the development of new programs, and to furnish the Congress with the information necessary for authorization of appropriations for fiscal years beginning after June 30, 1968, the Secretary, in cooperation with State water pollution control agencies and other water pollution control planning agencies, shall make a detailed estimate of the cost of carrying out the provisions of this Act; a comprehensive study of the economic impact on affected units of government of the cost of installation of treatment of facilities; and a comprehensive analysis of the national requirements for and the cost of treating municipal, industrial, and other effluent to attain such water quality standards as established pursuant to this Act or applicable state law. . . .

Section 18: The Secretary of the Interior shall conduct a full and complete investigation and study of methods for providing incentives designed to assist in the construction of facilities and works by industry designed to reduce or abate water pollution. Such study shall include, but not be limited to, the possible use of tax incentives as well as other methods of financial assistance. In carrying out this study the Secretary shall consult with the Secretary of the Treasury as well as the head of any other appropriate department or agency of the Federal Government.

A coordinating mechanism was established by the President in his memorandum of April 21, 1967, which stated in part:

"The other area requiring attention is the consideration of economic incentives for pollution control and the determination of the economic effects of pollution control. In my message to the Congress on Protecting Our National Heritage. I asked Secretary Gardner and the Chairman of the Council of Economic Advisers to explore appropriate measures to encourage industry and local governments to abate pollution. This effort should be expanded to cover the effects of air pollution control on industry and trade, both foreign and domestic."

As a result of these actions, a Federal Committee on the Economic Impact of Pollution Abatement was established with chairmanship in the Council of Economic Advisers. In both of these areas, as in all areas related to science and technology, however, OST has a mixed responsibility: (1) to maintain an overview of programs; (2) to encourage agency efforts directed toward the resolution of all aspects of science-based problems; and (3) to undertake studies in major problem areas involving science and technology, and to assure proper scientific and technologic inputs into studies of economic, social and political implications of environmental problems.

Question 18. In his testimony, Dr. Buckley indicated that of the $185 million the Federal Government was spending in 1968 related to pollution, about $5 million was being spent on the social, economic and legal aspects of pollution. Do you believe this is a proper ratio regarding new technology versus assessing the implications of that technology?

Answer. There is inadequate emphasis currently on social, economic, and legal studies related to pollution. In the amended tables, the expenditures for research in this area are $2.7 million, rather than the $4.6 million mentioned at the Hearings.

Until comparatively recently, we have had little information on the effects of pollution, this situation is improving. Without these basic data, it has been impossible to evaluate social, economic or political alternatives for developing abatement programs and applying technology for control.

Probably our greatest problems rest in institutionalizing abatement programs. Political jurisdictions usually do not coincide with pollution patterns; and all industries do not pollute equally, which suggests that selective abatement may be appropriate. Inadequate attention to questions such as these may result in economic mistakes of considerable magnitude.

An expansion of efforts in these kinds of areas is undoubtedly warranted.

Question.—Please supply a list of the social, economic, and legal studies which are being undertaken.

The requested list of current studies follows:

Department of Commerce

Distribution of Expenditures for Water and Sewage Systems;

Legislative History and Bibliography—Air and Water Pollution;

Water and Air Pollution Control Programs of the Pulp Industry;

Research (BDSA-OAAIA) (Projections of value added for 50 major polluting industries).

Department of Health, Education, and Welfare

Methodology for Studying Socio-Economic Effects of Air Pollution;

Air Pollution Control Costs;

Effects of Air Pollution on Optimal Urban Form;

Effect of Region on Air Pollution Control Programs;

The Organizational Factors in Air Pollution Control;

USSR Literature on Air Pollution and Related Diseases;

Air Pollution Control Political Process Conference;

Social Consequences of Use of Human Research Subjects—Economic Cost of Employee Illness or Death Caused by Industrial Pollutants;

Solid Wastes Operations Methodology Research for Optimum Management System;

Systems Analysis of Solid Wastes Management;

Cause and Effect Relations by Mathematical Models for Optimal Systems Operations;

Markets for Solid Wastes and Related Materials;

Management-oriented Municipal Cost Accounting Procedures for Analysis of Solid Wastes Problem;

Solid Wastes Cost Indices;

Funding Guidelines for Solid Waste Activities;

Cost-Benefit Relations of Solid Wastes Management;

Manpower Requirements, Union and Organized Labor Relations to Solid Wastes Management Systems;

National Survey of Community Solid Wastes Practices, etc., Statistical Data Processing-Mathematical Relationships;

State Solid Wastes Planning Guidelines Including Technical and Administrative Assistance;

Review of State Plans (Solid Wastes);

Relations and Economic Impact of Solid Wastes Disposal Activities on Land Use Patterns;

Regional and National Bases of Costs and Benefits Associated with State Solid Waste Management Plans;

Environmental Interfaces of Solid Wastes System and Interrelationships with Planning Processes;

Guidelines, Criteria and Standards for Solid Waste Management Systems;

Model Codes, Ordinances and Statutes for Urban, Regional and State Agencies;

Development of Training Courses for Public Officials;

Technical-Economic Study of Waste Disposal Needs and Practices;

Economic Study of Yeast Production;

Application of Systems Concepts to Solid Wastes Management;

Proposal for Improved Refuse Collection, a Comparative Study of One-Man Operation;

Systems Analysis of Solid Wastes;

Consumer Attitudes Toward Mineral Taste in Domestic Water;

Dynamic Evaluation Procedure; Refuse Handling System;

Using Waste Formed in Vegetable and Cheese Production;

Citric Acid From Citrus Wastes by Fermentation;

Systems Analysis for Shipborne Municipal Incineration;

Gully Reclamation Method—Landfill Demonstration, Nebraska;

California Integrated Solid Waste Management System;

Patterson, Clifton, Passaic, Wayne, Regional Solid Waste Program.

San Jose/Santa Clara County, Solid Waste Disposal Demonstration Project;

Erie County Refuse Disposal Project;

Maricopa County-wide Solid Waste Disposal;

County-wide Sanitary Landfill Refuse Disposal Project—Broome County, New York;

Des Moines, Metropolitan Area Solid Waste Study and Investigation;

Developments of Master Plan for Solid Waste Collection and Disposal, New Orleans, La.;

Farmington River Valley Solid Waste Disposal Study and Investigation;

Solid Waste Disposal Study for Flint and Genesee County, Metropolitan Area, Michigan;

Western Jefferson County, Wisconsin Solid Waste Disposal Study;

Solid Waste Collection and Disposal Study, Harrison County, Mississippi;

Tocks Island Regional-Interstate (Pa., N.J., and N.Y.) Solid Waste Management Study;

Study and Investigation and Solid Waste in Appalachian Regional Demonstration Area—Ten Counties in West Virginia;

Comprehensive Study of Solid Waste Disposal, Cascade County, Montana.

Department of the Interior

Delaware Estuary and Bay Water Quality Sampling and Mathematical Modeling;

Interstate Regional Planning for Water Supply and Waste Disposal;

Water Rights Related to Water Quality Storage;

Economics of Water Quality for a Regional System;

The Economics of Water Supply and Quality;

Economic Evaluation of Water Quality;

A Mathematical Model for Regional Treatment;

Data Collection Economics for Water Pollution Studies;

Mathematical Models of Hydrologic Systems;

Economics of Multi-purpose Playa Lake Modification;

Studies on Effects of Watershed Practices on Streams;

Use of New Analytical Methods for Water Resources Development;

Effects of Water Pollution in San Francisco Bay;

Water Quality Management on the Wisconsin River;

Alternative Economic Responses to the Acid Mine Drainage Problem in Southeastern Ohio;

The Effect of Quality Factors on the Demand for Water-Based Recreation;

Economic Factors in the Establishment of Water Quality Stream Standards;

Industrial Water and Waste Disposal Requirements in New Jersey;

A Case Study of Attitudes of Local Decision-Makers Toward Water Pollution Abatement in Selected Massachusetts Communities on the Connecticut River;

The Law of Water Pollution Control;

A Comparison of State Water Pollution Control Laws and Programs;

Economic Analysis of Alternative Water Pollution Control Measures;

Pollution Taxes and the Costs of Water Quality Management;

Study of Relationships Between Water Pollution and Industrial Development in South Carolina;

Economic Factors in the Establishment of Water Quality Stream Standards;

Industrial Water and Waste Disposal Requirements in New Jersey;

Integration of Connecticut Water Rights Laws and Pollution Control Laws;

The Effectiveness of Governmental Action for Water Pollution Control in New Jersey;

Water Quality Management on the Wisconsin River;

Stream Pollution and Recreation;

The Impact of Imposing a Water Quality Standard on a Live Stream;

The Use of Taxes, Subsidies, and Regulations to Control the Effluent of the Textile Industry;

Survey of Water Quality Requirements in Alaskan Campgrounds With Projections of Recreation Demands and Benefit/Cost Analysis for Site Selection.

Department of Agriculture

Economic Analysis of Water Pollution by Pesticides and Other Agricultural Wastes;

Legal Aspects of Water Quality Standards and Enforcement as Related to Agriculture and Rural Resources;

Economic Studies of Fertilizer Use;

Economic Analysis of Animal Waste Disposal in Farm Management;

Disposal and Utilization of Wastes for Agricultural Processing (Economics of Marketing By-Product Wastes);

Welfare and Institutional Economics in Analyses of Water Resource Management Problems; and Water Quality Management in Small Watersheds;

Economic Effects of Pesticides and Other Wastes on Natural Resources Quality;

Economic Studies of Sediment Control.

(Submitted by Mr. Ryan:)

Question 19. In order to better understand the role that the Office of Science and Technology plays in the decision-making process, would you please explain what role it played in the decision to proceed with the SST. Was the question of sonic boom, including its physiological and psychological effects upon man, studied by OST, and were these factors really taken into consideration in the decision to proceed with the SST? Did your office advise that the SST may never be able to fly over land or was this possibility considered?

Answer. The Director of OST sat with the President's Advisory Committee on the SST, chaired by Secretary McNamara, and participated in its deliberations. OST also worked closely with the Committee on the Sonic Boom of the National Academy, which was set up at the President's request, and insured that its review was carefully considered by the McNamara Committee.

At the request of the Chairman of the President's Advisory Committee on the SST (PAC–SST), Secretary McNamara, Dr. Hornig later assumed direction of an interagency sonic boom study program. This interagency effort was advised by the National Academy of Sciences Committee on Sonic Boom and carried out by USAF and various contractors, including the Stanford Research Institute. Naturally, the central problem of interest in these studies was the suitability of SST's of various design for commercial overland flight. The effects of sonic booms on structures, animals and people were included in the studies directed by OST and the principal conclusions included in a report which was released to the public. Studies are still continuing but now they are under the direction of the Department of Transportation.

(Submitted by Mr. Bell:)

Question 20. In your prepared statement you indicated that systems analyses would be used to help clarify some of the problems in pollution because of the sheer size and complexity of the problem.

(a) Is it expected that this effort will be done in-house or contracted out?

(b) If contracted out, is there the danger that a company which does the analyses will have a significant competitive advantage over other organizations regarding the development of hardware to combat pollution? How does the Federal Government protect against this possibility?

(c) Please discuss the possible use of the systems analyses capability of private industry in light of the October 1967 ruling of the Civil Service Commission suggesting that it is illegal in many instances to use contractor-supplied personnel to perform work ordinarily handled by Federal employees.

Answer. (a) The prepared statement indicated that the use of systems analysis has frequently been suggested to clarify problems we as a Nation are facing and to point the way to effective solutions. It further indicated that OST has "recently undertaken to clarify the possibilities and limitations of this approach".

Our initial action has been to bring together several persons skilled in systems analysis to explore the value of undertaking an objective analysis of the use and limitations of systems analyses as a guide to those in public decision-making positions. At the present time OST does not propose to directly involve itself in an operational program in the application of systems analyses.

(b) As indicated in (a) above, no contractual work is now planned by OST. In response to the general nature of the question, it is potentially true that any non-governmental firm might gain some advantage through contractual or other work programs in which they might engage with Government. Systems analysis, more usually, would involve a planning process rather than hardware development, although there would be exceptions to this.

(c) Civil Service Commission rulings are, of course, to be followed. In relation to systems analyses capability of private industry, it is likely that Government will use such outside help on specific research tasks or other related matters as necessary. For usual program analyses, Government agencies are prepared or are preparing to carry out needed tasks involving systems analyses with their own staffs.

Mr. DADDARIO. Our next witness is Dr. John Buckley, who has been of great help to this committee on several occasions. We are pleased to have you here this morning, Dr. Buckley. Dr. Buckley is Director of the Office of Ecology in the Department of Interior, but today he is here representing the Committee on Environmental Quality of the Federal Council on Science and Technology.

(Dr. Buckley's biography follows:)

DR. JOHN L. BUCKLEY

Education: BS, New York State College of Forestry, MS, PhD (wildlife management).

Professional history: Professor of wildlife management; asst. chief, wildlife research branch. Bureau of Sport Fisheries and Wildlife, director, Patuxent Wildlife Research Refuge, chief, Office of Pesticides Coordination, Bureau of Sport Fisheries and Wildlife.

Affiliations: National Research Council; AAAS, Wildlife Society; Arctic Institute.

Fields of special competence: Wildlife ecology, population fluctuations; environmental contamination.

STATEMENT OF DR. JOHN L. BUCKLEY, COMMITTEE ON ENVIRONMENTAL QUALITY, FEDERAL COUNSEL FOR SCIENCE AND TECHNOLOGY

Dr. BUCKLEY. Thank you, Mr. Chairman. It is a privilege to be here and I am sorry I am disorganized as usual. The large stack of papers here is witness to this.

The principal item I wish to lay before the group this morning is what we consider to be the best summary available at this time of expenditures on pollution research in the Federal Government. The last of the addition on the individual pieces was finished at 1 o'clock this morning and the summary at 10 minutes of 10. If there are some arithmetic errors, I hope the committee will permit me to make some changes in the fairly near future.

In the interests of time, Mr. Chairman, I will skip through the testimony here quite rapidly and request my prepared statement be included here.

(The statement follows:)

PREPARED STATEMENT OF JOHN L. BUCKLEY, CHAIRMAN, RESEARCH, DEMONSTRATION, AND DEVELOPMENT SUBCOMMITTEE OF THE FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY'S COMMITTEE ON ENVIRONMENTAL QUALITY

The decision to form a Research, Development, and Demonstration Subcommittee was reached at a meeting of the Committee on Environmental Quality on August 22, 1967. The minutes of the next Committee meeting on September 12, 1967, show that:

> Two major activities of the Subcommittee on Research, Development, and Demonstration will be (1) to review the ongoing research program with a view to understanding how rapidly answers are accumulating; and (2) to review the priority and balance of the proposed program. Inherent in both review activities is the desirability of assuring covering of gaps and preventing unplanned overlap. Trends in intra-mural vs. extra-mural research will be studied, especially as they relate to manpower.

The Subcommittee held a series of meetings through the early fall at which it discussed how it could best gather the necessary information to carry out these duties. The possibility of obtaining the required information from the Defense Documentation Center or from the Scientific Information Exchange was discussed, but a trial run with the Defense Documentation Center suggested that problems of definition would be exceedingly difficult. It was therefore concluded that we should simultaneously query these information systems and the Government departments and agencies known to have programs in this area (a preliminary result from the Science Information Exchange is shown in Appendix 4). This would provide us with a useful base of information together with some insights into the ways in which we can best use the established information systems. A copy of the questions and instruction sheet that went to the Government departments and agencies is attached as Appendix 1.

Basically, the Research, Development, and Demonstration Subcommittee intended to find out how much of what kinds of research was being conducted by whom and with what results in the areas of understanding and controlling pollution. With such a base of information, it should be possible to determine what is being done; to assess in some measure the balance of the programs; and the data acquired should supply a useful basis for evaluating priorities. (Parenthetically, it is necessary to note that the Subcommittee recognizes that each Federal agency supports the research that is most urgent in the conduct of its own mission; it is possible, however, that the "mix" of research developed by the several departments and agencies may not be the optimum for the nation as a whole.) Only with a factual background describing today's program is it possible to enter upon a meaningful evaluation of these questions.

Table 1 provides the results from the questionnaire. It is quite certain that this table is the best representation so far obtained of Federal efforts in research, development, and demonstration related to pollution. At the same time, we are aware of a number of items that must be considered in using this table. First, the footnotes to the table indicate that there is a considerable amount of transfer of funds within the Government aimed at the most efficient solving of problems. We have attempted to identify such moneys so that there is no "double counting" in the funds. Second, data were already available on funds spent on pesticide research in fiscal year 1967 and it did not seem fruitful to ask each agency again to supply the information. The 1967 pesticide data were gathered under the auspices of the Federal Committee on Pest Control, which kindly made the data available. They are included in Table 2. There is a small amount of pesticide research also reported in Table 1 but we believe this to be less than $2 million. Third, for purposes of our tabulations, intramural is considered as work done by Federal employees. Fourth, and very much to the point, much of the research, demonstration, and development reported here is directly pertinent to understanding and controlling pollution, but would be conducted for other reasons even if we were not supporting pollution control at the Federal level. Thus, better means of pest control and improved combustion are both desirable for increased efficiency. They also both contribute to reduction of pollution. We have identified some moneys of this sort but believe much more detailed analysis is necessary to really understand this factor. Fifth, investigations and research on pollution control are required as part of any military research, development, test, and evaluation program (reference to DOD Directive 5100.50). It is difficult, if not impossible, to separately identify all research on the problem, since a large effort is undertaken with regard to systems effectiveness, or military personnel protection. The data on pollution research cost thus do not include many such expenditures.

The Subcommittee considers its most important task the evaluation of the material supplied in response to Part II of the questionnaire. Several approaches have been taken by different agencies. One, by the Federal Water Pollution Control Administration, consists of a presentation of research on "effects of pollution" in the form of a matrix. A part of this is supplied as Appendix 2 to demonstrate this approach. Another, developed by the Public Health Service, requires a relatively elaborate coding but permits display of a large amount of data on a single sheet. An example is shown as Appendix 3.

I appreciate the chance to appear before your Committee and to describe the activities of the Research, Development, and Demonstration Subcommittee of the Committee on Environmental Quality. Many of the Subcommittee members are in the Hearing room and between us we will be pleased to try and answer any questions you may have.

Thank you.

TABLE 1.—EXPENDITURES REPORTED BY THE FEDERAL GOVERNMENT ON POLLUTION RESEARCH, DEVELOPMENT, AND DEMONSTRATION (EXCEPT PESTICIDES) IN FISCAL YEAR 1968

[Thousands of dollars]

	Fiscal year 1967				Fiscal year 1968		
	Including pesticides	Excluding pesticides			Excluding pesticides		
	Total	Intramural	Extramural	Total	Intramural	Extramural	Total
1. Effects of pollution	44,258	12,891	22,152	35,764	16,294	25,188	41,943
(a) Directly on man	17,508	6,463	6,123	12,645	8,960	5,601	14,632
(b) On crop plants and domestic animals	5,234	753	2,731	3,484	1,418	2,617	4,035
(c) On nondomesticated plants and animals	9,256	2,200	4,513	7,375	2,324	4,745	7,459
(d) On laboratory animals	6,289	....	6,289	6,289	....	6,808	6,808
(e) On materials or structures	414	249	165	414	304	229	533
(f) On environments	(5,481)	(3,201)	(2,280)	(5,481)	(3,263)	(4,982)	(8,245)
(1) Air	736	352	384	736	302	242	544
(2) Freshwater (eutrophication)	1,742	1,101	641	1,742	960	1,603	2,563
(3) Marine	873	683	190	873	701	320	1,021
(4) Urban	155	....	155	155	50	1,076	1,126
(5) Rural	1,050	1,000	50	1,050	1,150	453	1,603
(6) Wild	....	....	....	....	....	....	....
(7) Soils	65	65	....	65	65	....	65
(8) Mixed	202	....	202	202	....	598	598
2. Transport, distribution, and fate of pollutants	29,586	5,247	12,941	18,602	5,830	13,003	19,090
(a) Movement	16,002	4,571	11,431	16,002	4,884	10,996	15,880
(b) Degradation	2,186	676	1,510	2,186	946	2,007	2,953
3. Mesaurement and instrumentation	14,736	6,836	4,083	11,536	7,090	4,296	12,042
4. Exposure to and sources of pollution	2,403	1,782	621	2,403	2,341	747	3,088
5. Social, economic, and legal aspects of pollution	1,891	319	1,572	1,891	684	2,022	2,706
6. Prevention and control of pollution	118,967	25,832	49,826	75,779	31,142	74,414	105,666
(a) Research	66,195	13,171	17,153	30,445	16,782	18,612	35,504
(d) Development	29,272	2,951	18,883	21,834	3,812	30,709	34,521
(c) Demonstration	23,500	9,710	13,790	23,500	10,548	25,093	35,641
Total obligations	211,841	52,907	92,195	145,975	63,381	119,670	184,535

Note: Fiscal year totals and numbered category totals may exceed the sums of the respective rows and columns because some agencies did not provide detailed breakdowns. Research and development estimated at $132,600,000 in fiscal year 1967 and $136,500,000 in fiscal year 1968 not conducted for pollution-related purposes also contributes to understanding and controlling pollution. $9,000,000 of this in fiscal year 1967 and $10,000,000 in fiscal year 1968 was spent on aircraft noise.

TABLE 2.—*Pesticides research conducted or supported by the Federal Government*[1] *in fiscal year 1967. Data gathered and supplied by the Federal Committee on Pest Control (FCPC)*

[Thousands of dollars]

1. Effects of pollution[2]	8,494.6
(a) Directly on man	4,862.9
(b) On crop plants and domestic animals	1,750.4
(c) On nondomesticated plants and animals	1,881.3
(d) On materials or structures	
(e) On environments:	
(1) Air	
(2) Freshwater (eutrophication)	
(3) Marine	
(4) Urban	
(5) Rural	
(6) Wild	
2. Transport, distribution[3] and fate of pollutants	10,985.2
(a) Movement	
(b) Degradation	
3. Measurement and[4] instrumentation	3,200.4
4. Exposure to and sources of pollution	
5. Social, economic, and legal aspects of pollution	
6. Prevention and control[5] of pollution	43,188.5
(a) Research	
(b) Development	
(c) Demonstration	
Total obligations	65,868.7

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[1] Includes data from Department of Agriculture, Defense, Health, Education, and Welfare, and Interior, and from the Atomic Energy Commission, National Science Foundation, and the Tennessee Valley Authority.

[2] Included as categories B–3 and D on the FCPC questionnaire.

[3] Included as category E–1 on the FCPC questionnaire.

[4] Included as category F on the FCPC questionnaire.

[5] Included as categories C1–11 and E–2 on the FCPC questionnaire.

APPENDIX 1. QUESTIONNAIRE AND INSTRUCTION SHEET ON RESEARCH, DEVELOPMENT AND DEMONSTRATION OF POLLUTION

(Instructions for Questionnaire on Pollution Research, Development, and Demonstration Supported or Conducted by the Federal Government)

1. On each questionnaire sheet indicate organization to which the response applies.

2. On Part I of questionnaire, include fiscal year 1967 and expected fiscal year 1968 funds.

3. Pollution, for purposes of this questionnaire, is defined as follows:

"Environmental pollution is the unfavorable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms. These changes may affect man directly, or through his supplies of water and of agricultural and other biological products, his physical objects or possessions, or his opportunities for recreation and appreciation of nature."

4. On Part II, indicate the subjects or fields in which work is performed, but not the funds or manpower involved.

5. Pesticides need not be included because necessary information is available from the recently completed study of the Federal Committee on Pest Control.

6. Those who prepare this information are cautioned to retain their working papers. Questions generated by this study that cannot be answered by the report of this study will be referred to the appropriate agencies. It is probable that this study will be repeated in the future; therefore, the working papers will be of assistance in preparing future inputs.

7. Members of the Research, Development, and Demonstration Subcommittee will be glad to answer questions that arise in the course of completing the questionnaire. Members are:

Dr. John L. Buckley—USDI
Code 183–4091
Dr. Helmut K. Buechner—Smithsonian
Code 144–5945
Mr. Jared J. Davis—AEC
Code 119–4155
Dr. Edward S. Deevey—NSF
Code 183–7888
Dr. Louis B. C. Fong—NASA
Code 13–27695
Col. Alvin F. Meyer, Jr.—DOD
Code 11–69377
Dr. Cecil H. Wadleigh—USDA
Code 1233–571
Dr. Douglas L. Worf—PHS
Code 13–22575

QUESTIONNAIRE ON POLLUTION RESEARCH, DEVELOPMENT, AND DEMONSTRATION SUPPORTED OR CONDUCTED BY THE FEDERAL GOVERNMENT

Part I—Obligations (rather than Expenditures) Fiscal Year 1967 and Fiscal Year 1968. Include *all* funds obligated. (Indicate separately any funds *received from* other Federal agencies.) Show intramural and extramural separately.

1. Effects of pollutants or pollution.
    - (a) Directly on man.
    - (b) On crop plants and domestic animals.
    - (c) On non-domesticated plants and animals.
    - (d) On materials or structures.
    - (e) On environments:
        - (1) Air e.g., inadvertent weather modification.
        - (2) Freshwater e.g., eutrophication.
        - (3) Marine (including estuaries) e.g.
        - (4) Urban e.g.
        - (5) Rural e.g.
        - (6) Wild e.g.

[Effects included here are those exerted on a whole system rather than on its separate parts. Do *not* report research here that is reported under (a)-(d)]

2. Transport, distribution, and fate, including accumulation and degradation of pollutants.
    - (a) Movement—including physical and biological movements (cycling).
    - (b) Degradation—physical or chemical changes.
3. Measurement and instrumentation.
4. Exposure to and sources of pollution.
5. Social, economic, and legal aspects of pollution.
6. Prevention and control of pollution.
    - (a) Research
    - (b) Development
    - (c) Demonstration

Part II—Research on pollution. Details of research conducted or supported by agency. Include all R D & D conducted regardless of source of funds, and all R D & D you support outside Federal Government. The following descriptions of categories are to be used:

Include support of all research directed toward understanding and controlling pollution, such as bio-geo-chemical cycling, study of unpolluted control areas, etc. Responses may be in tabular form.

1. *Effects.*—Each report should show what organism or group of organisms, or community or ecosystem is being studied; what pollutants or kinds of pollution, including noise and heat are being studied; what kinds of effects are being measured, such as mortality, behavior, physicological changes, etc. Pollutants may affect individuals, populations, communities of plants and animals, or ecosystems. The kinds of effects for *individuals* may range from death to subtle behavioral changes; for *populations*, in addition, they may include changes in natality and mortality rates and other population parameters; for *plant and animal communities*, they may also include changes in species in the community; and in *ecosystems* that may include altered rates of such processes as photosynthesis, bio-geo-chemical cycling, etc. For experimental work, the kinds of pollutants should be specifically listed to include each chemical compound with some indication of the rage of concentrations, mode of exposure and combina-

tions with other environmental factors; or in the case of noise, light, heat, etc., pertinent descriptions should be included. Be as specific as possible here. Each substance or kind of pollution should be related to a particular species and kind of effects under investigation. As much of the foregoing material as is applicable should be supplied for epidemiological studies.

2. *Transport, distribution, and degradation.*—The whole array of physical, chemical, and biological processes involved in movement of pollutants in the environment is of concern. Aside from the obvious distribution of pollutants poured into our waterways, or air pollutants released into the atmosphere by combustion, other substances are included. For example, pesticides which are applied to farm fields may move to the atmosphere as vapor, or as solids or liquids attached to airborne particles; or may be washed into water courses; or may be picked up and incorporated into the plant and animal tissues and transported with these. Thus, studies of atmospheric circulation, the hydrologic cycle, migratory patterns of birds or fishes, and marketing patterns of agricultural produce may all contribute directly to understanding this problem. The locus, rates, and kinds of changes that take place in the pollutants also are of concern, and studies on atmospheric chemistry and metabolic alteration are included here.

3. *Measurement and instrumentation.*—Studies devoted to the detection, identification, and quantification of pollutants or effects of pollutants are included here. Because such measurements are so closely related to instrumentation, instrument development is also included.

4. *Exposure to and sources of pollution.*—The exposure to the same pollutant from various sources (e.g., lead in air, water, and food) and the relative contribution of different sources of the same pollutant or pollution is the central issue here. For example, carbon dioxide may come from volcanos, forest fires, respiration, power generation, and a whole host of other sources of combustion; the hydrocarbons in the atmoshpere come from volatiles produced from growing trees, from combustion in motor vehicles, from combustion (and lack of combustion) in jet aircraft and diesel engines, etc.

5. *Social, economic, and legal aspects of pollution.*—Attitudes, likes and dislikes, political organization related to control, etc.

6. *Control of pollution.*—Control of pollution or, more properly, management of pollution may include prevention through use of a non-polluting technology; removal of pollutants that are formed before they enter the environment; or treatment of some part of the environment to remove the pollutant. Research here will grade into development and on into demonstration where the intent is to gradually move a laboratory discovery into a practical operating system or device which the public or some segment of it can be convinced to use.

APPENDIX 4 (TO TESTIMONY OF DR. JOHN L. BUCKLEY)

FEDERAL SUPPORT FOR FISCAL YEAR 1967 ON POLLUTION—AIR, SOIL, AND WATER

Agency	Extramural			Intramural		
	With funds	Without funds	Funds	With funds	Without funds	Funds
USDA	8	76	$104,818		36	
AEC	34	3	1,244,174		12	
Commerce	2	3	111,100	35	1	$2,694,940
DOD	19	11	625,000	15	13	340,000
HEW	213	1	8,680,905	12	2	434,550
HUD	1	1	26,650			
Interior	396	41	10,248,551	61	87	2,872,852
NASA	8	2	1,136,000	1		123,000
NSF	17		662,200			
TVA		1			13	
VA					11	
Total	698	139	22,839,398	124	175	6,465,342

Note: The statistics in this table represent only those research grants and contracts registered with the Science Information Exchange by Federal granting agencies.

GENERAL SIGNIFICANCE OF S.I.E. COMPILATIONS

Compilation of data from Science Information Exchange (S.I.E.) are subject to some inherent limitations and exceptions. Wherever possible, S.I.E. will note and estimate the significance of these conditions as they apply to each compilation. There are also the general limitations noted below that should be recognized in order to avoid possible misinterpretation, confusion, and contradictory conclusions, when comparing these data with other sources.

S.I.E. is an inventory of research tasks, where "task" means a small uniquely identified unit of research work.

The dollar values recorded by S.I.E. are intended only to show the annual level of effort (or support) for each individual task.

Sums, totals, and compilations of S.I.E.'s research task records are not designed to reflect budget data. Therefore, S.I.E. dollars sums and totals cannot be reconciled with budgets that are essentially inventories of total dollars. The latter allocates all R.&D. dollars to specified categories. S.I.E. counts only those dollars that are annually allocated to a selected list of items identified as basic and applied research tasks. This does not include many categories of overhead, general support, construction, fellowships, etc.

S.I.E. dollar sums and totals can be used as a comparative *index of relative emphasis* and distribution among agencies, or recipients, or geographical areas, of subject fields, etc., for one or a series of years, if the inherent limitations and exceptions are clearly recognized in each case and applied to the derivation of conclusions. For example:

(1) S.I.E. receives no research records classified for national security.

(2) S.I.E. receives no dollar values for most inhouse research tasks.

(3) At this time, S.I.E. receives few records of development projects and programs.

In comparing S.I.E. data with other sources, it should be noted that many projects and tasks are on the borderline between applied research, advanced technology, and development. The decision for inclusion or exclusion is abritrary, and may differ among agencies, and by individuals. These may total fairly large sums, and corresponding discrepancies.

(4) S.I.E. focuses on the research task, *per se*. Contracts, grants, and funds allocated to general research support, such as interdisciplinary laboratories, institutional grants, etc. that are not related to specific research tasks may not come to S.I.E. or may be accounted differently.

(5) S.I.E. registers research tasks according to the fiscal year in which the research began. This may or may not agree with the fiscal year in which the funds were budgeted, committed, or obligated.

(6) S.I.E. records the *annual cost* (level of effort) for a grant or contract that may extent over several years. Some agencies assign the budget cost of a single 3-year grant to one fiscal year, in compiling their reports.

(7) S.I.E. can only report on tasks that have been registered by the participating Agencies. All Federal Agencies do not register their entire programs so that S.I.E. can not guarantee complete coverage for any given program, subject, or agency.

(8) The S.I.E. collection has grown rapidly over the years as agencies have initiated and/or increased their registration. Comparative trends over a series of years in some categories may reflect the growth of the Exchange rather than changing emphasis in the research area or program.

(9) With any compilation, S.I.E. will note and estimate the significance of these limitations, as far as possible, if requested to do so.

Dr. BUCKLEY. Dr. Hornig's statement pointed out the existence of this committee and the reason for it. I would like to start with a history of the actions the subcommittee has taken.

We spent some time discussing in the fall how we might best get at an understanding of what the pollution research program in the Federal Government was. One of the suggestions, and a useful one, was that we query the Department of Defense Documentation Center, and we did. This is one of five volumes of this size which describes individual undertakings that deal with pollution research in the Federal Government. It is a rather unmanageable document at this point in time. It has no figures in here on dollars. It includes many things which are important in understanding pollution, but just what to do with it and how to digest it has been beyond us so far.

We have also asked for similar kinds of information from the Science Information Exchange, managed by the Smithsonian Institution, and the printout from there I think will be even more voluminous than the one we have obtained this way. A preliminary tabulation on expenditures is appendix 4 to my prepared statement.

Our problem I think is not in obtaining sufficient information, our problem is trying to find it in a compact enough form to be useful to us.

Having basically looked at information readily available, we asked the agencies to supply responses to a questionnaire, a copy of which is present in the appendix to the prepared testimony here.

We did not ask about expenditures on pesticides or pest control-related research because these data had already been gathered by another group under the Federal Committee on Pest Control, which is made up of representatives of the Departments of Agriculture, Interior, Health, Education, and Welfare, and Defense. The data were similar enough that we have included them here in table 2 of this testimony. The total figures on 1967 expenditures which we thought related to pollution that was spent on pesticides and pest control research was $65,868,000. The other data gathered have not been summarized in all of the detail we would like as yet. The total expenditure in 1967 reported here is $146,890,000. In 1968, it has increased to $184,925,000. The overall totals, assuming the same level of pesticide research expenditures in fiscal year 1968 as in fiscal year 1967, would be at least $210 million in 1967 and $250 million in 1968.

I must point out that there are underestimates of the amount of money actually expended that is germane to research on understanding and controlling pollution. There are moneys in here, substantial amounts of them, which would be spent regardless of whether pollution was a problem or not. For example, there is a need to increase the efficiency of pest control for agricultural reasons, and the research devoted to improving control methods is included here because it does reduce, or will permit us to reduce the amount of pollution, but it equally would go on regardless of this particular problem, but perhaps not so vigorously.

The same thing applies to many other areas. Some of these are included, some are not. So the figures are inaccurate and underestimates to that degree.

In addition to asking for data on funds, we also asked the agencies to tell us as precisely as possible the kinds of research they were conducting. We have not progressed far with the analysis of these data. Some of the approaches to analyzing this information are included in part in several appendices to the prepared testimony here. One example is from the Federal Water Pollution Control Administration, the second one is from the Public Health Service.

The high points I would like to point out in the numbers as they exist here now are that in 1968, $45 million is programed for research on the effects of pollution—the effects of pollution on man, on crop plants and animals, on nondomesticated plants and animals, on materials or structures and in the environment in general, including air, fresh water and marine, and soils. This is less than one-fourth of the total money programed.

The second item is on transport and distribution and fate of pollutants, which is $20 million. The basic reason for undertaking research on effects of pollution is to achieve an understanding of how much of any particular pollutant we can tolerate without detriment to those things we want. At the same time, in order to understand where to take an action and how to control the levels, it is necessary to understand about the transport or movement of these pollutants. That is what the second item is.

The third one is easily understood, measurement and instrumentation, with $11 million expended in this field.

The next item queried here was on exposure to and sources of pollution. What we meant by this was the fact that some pollutants occur in a variety of different environments and reach man or the other targets in a variety of different ways. As, for example, lead from gasoline.

Also, it is the fact that a number of different sources may contribute to the pollution at a particular point, such as a variety of sources contributing sulfur oxides to the atmosphere, which may affect an individual at a given place. The amount of money expended here is $3 million.

For social, economic, and legal aspects of pollution, the total expenditure is somewhat less than $5 million. And more than half of the total expenditure, $99 million in this year, is intended to be spent on the prevention and control of pollution, that is research, development and demonstration, in this area.

Mr. Chairman, I think that summarizes what I now know about the expenditures of the Federal Government.

Mr. Daddario. Your total figure then comes to $184,926,000?

Dr. Buckley. That is correct, plus the estimated figure on pesticides.

For fiscal year 1967, an additional total of $65,870,000 was spent on pesticide research related to pollution.

Mr. Daddario. How do you see this figure going in the future? What do we need to do dollarwise, Doctor?

Dr. Buckley, I would rather talk about it with hindsight, Mr. Chairman.

Mr. Daddario. Look at it from hindsight then.

Dr. Buckley. It is quite clear it has increased and it is quite clear some parts of it will increase. Even in these 2 years, 1967 and 1968, it is clear a larger proportion of the total is devoted to applying what we know, finding how to apply this, how to control pollution and how to prevent pollution immediately in 1968 than it was in 1967. The amount we are spending that basically relates to standards, criteria, and understanding how much pollution we can tolerate has not increased as rapidly as this. I think this is a reasonable trend. There is a great deal that we know almost well enough to apply and where fairly small amounts in development and demonstration are likely to pay off. And that is one of the trends which is clear in the data at this time.

Mr. Daddario. You have put figures together but some of it is not yet in manageable form, but I am sure it will be. How do you plan to use it? Why have you done it, and what does this information allow you to do that you presently are not able to?

Dr. Buckley. In order to make any serious judgments on how much overlap there may be between programs of different agencies and, second and more particularly, what areas are not well covered, and third, to understand how well research is being conducted, how well the right programs and problems are being attacked, we felt it was necessary to have a base of solid information. That is the direction in which we are interested in heading.

I have noted in the written testimony here the fact that we are interested in this whole problem of priorities, but we have a firm belief that the individual agencies do a pretty good job of attacking the problems that seem to them the most pressing. The question becomes not so much whether the funds are well spent, but whether the mix across the Government as a whole, looking at the large problems of pollution, seems to be reasonably placed. We think again it will provide a basis for this and we hope to offer some comment on this at some time in the future.

Mr. Daddario. Follow that through a bit. Since you do come to an assessment of the quality of the work being done, how does it apply insofar as priorities are concerned. Do you see any problem in the mechanics of putting together this interagency situation, because obviously it needs to have some coordination?

Dr. Buckley. It certainly needs to have some coordination and it certainly has a considerable amount of it now and it is exercised both through the OST and the Bureau of the Budget, with the budgetmaking process and advisory function. OST feels here, and I think to a considerable extent, this committee may be in a position to avoid the confusion of committees, the Committee on Environmental Quality and its Research Subcommittee may be in position to provide information to OST and to the Bureau of the Budget which will be useful to them in these decisions.

On the other hand, we are touching on a general problem—there are some things that committees do well and one of them I think is the gathering of information and the sorting of this and placing it in appropriate perspective and the exchange of information that results from it. When one comes to the resolution of very real differences, I am not sure this can in fact be done by a committee. The committee can provide the information that other people can use in the process.

Have I evaded that one sufficiently?

Mr. Daddario. You are doing pretty well.

Dr. Buckley, agencies also do pretty well at recognizing what is popular. If they have pollution activity going on and know, as Mr. Ryan pointed out, that the public is demanding something be done, they do have a tendency to enlarge their activities. They may do it very well, but somebody has to see that what needs to be done is done and that the funds are directed in the proper way.

As I look at your testimony, there seems to be no real mechanism yet to be able to impose the necessary authority so that this might be done.

Dr. **Buckley**. I would suggest that that question is more appropriately directed to either Dr. Hornig or Dr. Bennett than it is to myself, but second, I was pointing out as far as the committee is concerned I do not know of any other effective way to gather together the basic information that is necessary to make judgments, and the next stage of it you have described is one of judgment. It is a matter of balance, how much of this should go in which direction.

I think as a committee we can provide a valuable service in gathering and arranging the data that describes today's programs and the whole of today's program as well.

May I point out a piece here from the Water Pollution Control Administration that looks as though it may have considerable promise as a way of getting an understanding of the research going on in the "effects" part of this. We will have a fairly elaborate matrix that will show across one side the species of organisms, plants and animals, algae, or man, on which experiments have been conducted and about which something is known in regard to any given set of pollutants which will be listed on the left side. And out of this, without saying how well it is done or how completely, a simple check mark will make clear whether at least there is some effort going on. I think it is one of the questions that comes up in trying to use such things as this document or the SIE document. No investigator ever understates what he is going to accomplish when he writes this so he talks about the whole range of pollutants he is interested in and perhaps the whole group of responses of a single organism or sometimes a whole range of organisms. If you go by this kind of statement, it tends to overstate the amount of effort, the amount of knowledge we so far have gathered.

We think the approach we have laid out here will point out more effectively than most have, at least the holes, and consequently, either permit a judgment as to whether it is necessary to fill these holes or whether they are quite rational.

Mr. **Daddario**. I agree with you that the question I put to you is not one you have the responsibility to answer. I do believe that Dr. Hornig should be charged with the responsibility of answering that question. At the same time, it does appear that your work gives us the basis upon which we can come to a determination as to what in fact is going on.

Dr. **Buckley**. I certainly hope so because a lot of work has gone into this on the part of many people other than myself. Most of the Subcommittee on Research is here in the room, and they are the ones who have done this. I am sure they are not the full audience we have but they are among the people present.

Mr. **Daddario**. It is the responsibility of this committee to make recommendations to the Congress as to how it does appear to work out. The work you are doing is extremely important from the standpoint of how we come to some policy judgment about that.

We are pleased to see what you have put together, and it gives me a feeling of optimism about the chances of doing something tangible and beneficial.

Dr. **Buckley**. Thank you, Mr. Chairman.

Mr. **Daddario**. Mr. Ryan?

Mr. **Ryan**. No questions.

Mr. **Daddario**. Mr. Winn?

Mr. **Winn**. Mr. Chairman, I am privileged to sit with this committee and I want to commend you on your line of questioning. The line that concerns most of us is exactly who is going to serve as a clearinghouse or the central agency for all of these many activities that are now underway. A lot of money is being spent. I think most of us are concerned about that.

I would like to ask, Dr. Buckley, maybe I did not understand you correctly, but there are five volumes of the size you referred to there on the table. You say you do not know what you are going to do with it.

Dr. **Buckley**. I said that, having queried the system, the way in which information was provided from it is not one that is useful to us in trying to understand what we wanted to do here. This is not a criticism of the system. This is a simple statement, for the reason that information that was put in here was for a very different reason and the key words that are available for sorting it out were not put in as a part of it. And you cannot use automatically an information or data system that already exists to withdraw those things that you may want if you did not know at the time you made the system you might want it. So if the basic information that you need is not present in the system, you cannot extract it and this is our problem.

The obvious thing seemed to us to go to existing systems and we did that, but we convinced ourselves in fairly short order it was not a manageable way of handling this particular problem.

Mr. **Winn**. I may not read you correctly yet, but it almost looks like putting 22 ballplayers on a football field without the ball.

Mr. **Daddario**. May I interject a thought here?

Mr. **Winn**. Yes.

Mr. **Daddario**. I know that we have some difficulty from time to time in reconciling figures from different departments on the same subject, and they do not necessarily tell you the same thing. But how will this be affected, as you understand it, by the planning program in the budget which is aimed at reconciling differences so that everybody is going to be speaking the same language? I know that is coming and it should give you some help. If not, are you going to be able to put this together so that it will in fact be meaningful?

Dr. **Buckley**. I will answer the last one first.

Yes, they can be put together in a way they are meaningful, and the information in here is valuable to us, but it is voluminous enough that the sheer weight of it does not permit you to boil this down as easily as getting it some other way. This will offer a very good cross-check in what information we have obtained in other ways.

As to the problems of whether the program planning and budgeting system will lead us to a common language in here that answers these questions, I am not prepared to say. It certainly will not worsen the situation, and very likely will markedly improve it.

We had some semantic difficulties, for example, even with the word "intramural," which to most of us simply means it is going to be done in the Federal Government. We found, when we tried to sit down and put the numbers together, intramural meant different things to different people. With some this is where you have a close enough control over the way the money is spent that you really are managing all of the details of it. Some of the people, however, may not be Government employees, they may be contract employees, and this leads us into the question as to what fraction of that is intramural and which is extramural. Or one of the other agencies felt it was extramural if they transferred the money to some other Federal agency which in turn used it within the Government, and this is intramural in the terms of use of Federal money. But we were trying to sort out from here the amount of money which was transferred between agencies to accomplish a more efficient use of this. And so had we not discovered this difference in the use of terms, we would have obscured that particular point.

Mr. **Winn.** Did you coordinate these five documents with industry or is it strictly Government?

Dr. **Buckley.** This is strictly Government. There will be some industry information in here when the contracts of the Federal agencies have been with non-Government agencies, but this represents only Federal money except insofar as there may be a cooperative project where there is some Federal and some non-Federal funds. This, incidentally, is one of the points we need to push and we intend to push. Recognizing that expenditures outside of the Federal Government are a very substantial part of this whole thing, we thought that perhaps the most useful way to do this would be through the National Academy of Science, National Academy of Engineering Environmental Science Board, and this is one of the groups we have talked with as to how to do this.

Mr. **Winn.** Thank you.

Mr. **Daddario.** Mr. Fulton?

Mr. **Fulton.** The question comes up as to who is making these decisions in the Bureau of the Budget. For example, when the Federal agencies and departments make their presentation of budget request and justification to the Bureau of the Budget, who in the Bureau, the number and type of personnel, make these judgments on these particular questions of preventing pollution? What kind of technical personnel are there as distinguished from people of accounting, bookkeeping, or fiscal procedures? Are there people of technical competence who make the judgments on major programs in the Bureau of the Budget on a system basis?

Dr. **Buckley.** Congressman Fulton, I am not going to answer the question in view of the fact I believe it much more appropriate for the Bureau of the Budget to do this.

Mr. **Fulton.** You are making the recommendations to certain people. If I were passing my recommendations over to the other side of the street, I would certainly look to see who I was passing them to.

Dr. **Buckley.** The Bureau of the Budget has observers on this committee and subcommittees here and so it is fed back in the deliberations of the group as they go along into the system in the Bureau of the Budget. As to who the individuals are, some of them are technically qualified individuals, others come from different backgrounds.

Mr. **Fulton.** How many are there?

Mr. **Daddario.** You have no way of knowing that?

Dr. **Buckley.** No. In a way it is the entire Bureau of the Budget.

Mr. **Fulton.** I checked the Bureau of the Budget regarding NASA's budget one time and found there were only five people of technical competence trying to make the decision on a $5 billion budget within 10 days. What is happening here? If nobody knows now, maybe you should check it?

Dr. BUCKLEY. I am sure, Congressman, not all the decisions are made in any one place in the Bureau of the Budget, not all of the preliminary decisions. The final decisions are always made in the same place. But I suspect those tend to be only the major ones. Certainly each of the individual agencies takes these matters through the respective examiners for that agency.

Mr. FULTON. That is correct, but again, with the chairman's permission, how do we get these decisions collected in a way that they are balanced? How do you make judgments not just on the fiscal procedures, accounting, and bookkeeping, but on a technical competence? How is that done?

Would you put a statement in the record on that and let it go? Obviously the people who are feeding the information into the Bureau of the Budget do not know what happens to it once it gets in.

Dr. BUCKLEY. Certainly, to some extent the Office of Science and Technology and many of its staff members participate in advising the Bureau of the Budget at the time decisions are made. So here is another way in which it is done. But I am not prepared to tell you what weight is given to any pieces.

Mr. FULTON. Is the decisionmaking process not on fiscal and accounting bases, but technical competency as among systems? I will appreciate it if you put it in the record.

Mr. DADDARIO. You asked if you could with my permission. I would like to comment on it. I have no objection to it. I do think from the standpoint of Dr. Buckley's testimony he has explained to us as a member of this committee he is putting together this information, but because of this difference in language that they do have a problem.

I would expect that the Bureau of the Budget has the same problem, unless they understand all of the language. If they do, it would be much clearer. So we can assume they do not.

Mr. FULTON. I did not want to go that far in my criticism, but I certainly wanted to put my finger on the focal point of where the problems come together once the information is obtained, which seems to be the Bureau of the Budget.

May I ask some short questions about your form here? You have the effects of pollution. Then you have, under "environment," fresh water. I understand by fresh water you mean bodies of water, either ponds, lakes, streams, creeks, rivers; is that right?

Dr. BUCKLEY. That is correct.

Mr. FULTON. And that by eutrophication I imagine you mean both artificial and natural feeding of that pond.

Dr. BUCKLEY. What we intended was to simply use that as an example of the kind of thing which affected not only an organism in the water but which affected the system of water as a whole, and we meant the same kind of questions, though there are not any catch words of the sort to apply to the others.

Mr. FULTON. You meant artificial and natural?

Dr. BUCKLEY. We meant understanding of the whole system of environment here in this case and not this alone. That was intended as an example rather than an individual specific item itself.

Mr. FULTON. So you mean eutrophication of the pollutants and not atrophication of the nutrients?

Dr. **Buckley**. Our concern is with the entire interaction of the pollutants and water insofar as it changes either one or the other one.

Mr. **Fulton**. Either artificially or naturally increased?

Dr. **Buckley**. Either artifically or naturally increased, or even without change insofar as someone is trying to understand the dynamic processes that go on.

Mr. **Fulton**. I love you scientists when you come here to us and use words which I am sure you expect to be over our heads.

Do you know whether it is rich in dissolved nutrients but frequently shallow and in seasonal oxygen deficiencies in the hypolimnion?

Dr. **Buckley**. No, sir.

On the other hand, I would think the seasonal oxygen deficiency in any of the stratified parts of the water may be of concern.

Mr. **Fulton**. When you are speaking of animals outside of men, you are speaking of both retromingent and nonmingent, I take it.

Dr. **Buckley**. To be truthful, I do not know whether I am. Your Greek is better than mine.

Mr. **Fulton**. That is all.

Mr. **Daddario**. Mr. Fulton, I do not know if you heard Dr. Buckley. He did say he thought your Greek was better than his. All I can say, this has all become Greek to me.

Mr. **Fulton**. I enjoy these big words.

Mr. **Daddario**. Dr. Buckley, I hope you might sometime in the next few weeks go over the chart so there will be no question but that it is mathematically in order. Mr. Carpenter will be in touch with you so that it may be submitted for the record.

I would like to make an observation and ask a question. When we came to prophecies about this problem last year, we did feel that the present level of research, development, and demonstration funding in this whole area would most likely tend in the next several years to some $300 million. This is the reason I asked you the question earlier. You are already to $184 million plus. I wonder if it appears to you this is the direction in which it is going.

Dr. **Buckley**. I have no doubt but what that is the direction in which it is going. At the same time there is this problem of what one counts in and what he does not. So I do not really want to get involved in numbers. I think the trends shown on here are really fairly good representations of the way things are and how close to the number you quote of $300 million we are right now—this is the best estimate I can give you now.

Mr. **Daddario**. These are only estimates and they appear to be generally following the same direction.

Tomorrow this committee will have before it Dr. John Middleton, Director of the National Center for Air Pollution Control, Department of Health, Education, and Welfare, and Dr. Walter Hibbard, who is Director of the Bureau of Mines, Department of the Interior.

We want to thank you, Dr. Buckley, for your testimony and thank the members of the committee for having been here. We will adjourn until tomorrow morning at 10 o'clock at the same time and place.

Mr. **Fulton**. I would like to compliment Dr. Buckley too and hope when you come back again you will break these big words down a little for us. But I must say your perspicacity is equal to your perspicuity.

Mr. **Daddario.** I think Dr. Buckley will be using different words when he comes to the committee the next time.

(Whereupon, at 12:15 p.m., the committee adjourned, to reconvene at 10 a.m., Thursday, January 18, 1968.)

ENVIRONMENTAL QUALITY

THURSDAY, JANUARY 18, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order.

Today's testimony will deal with air pollution. The Air Quality Act of 1967 establishes a sequence of activities leading finally to enforcement of emission restrictions in order to assure the sort of air quality which society chooses to have. The first step is to promulgate criteria; that is, descriptions of the way in which pollutants damage the environment. Not only is this the first step toward clean air but it seems to be the most difficult to achieve.

There are, of course, pollution problems where the criteria can be established with little trouble and with little help from science. Pittsburgh and St. Louis citizens could decide to eliminate particulate matter from the air on the basis of what their eyes have told them to do about sources and effects which are visible.

Los Angeles inhabitants need no instruments to gage the level of eye irritating oxidants in the atmosphere. However, as the monitoring of urban air composition has proceeded in the past few years some contaminants have been identified which produce no immediate effect on human senses. They are invisible to the citizen. By their chemical nature these contaminants are inferred to react with materials, plants, and within the body, but we must count on science to tell us when we are being exposed to these pollutants and what the response will be in terms of health and welfare.

Therefore the new law makes the scientific basis of criteria, as I see it, the first order of business. The responsibility is squarely on the scientific community and research management to produce sufficient facts for administrative judgment.

Unfortunately science policy issues are abundant in which scientists do not agree with one another. Regardless of the eventual reconciliation inherent in the scientific method, this subcommittee has witnessed some pretty ragged arguments among technical people.

Air quality criteria is no exception. We are not so much interested in the pros and cons on a particular pollutant as we are in the ability of environmental epidemiology to resolve these matters. I believe there may be a danger that the Air Quality Act will be prevented from working in a timely manner if criteria setting cannot proceed, which is acceptable to public health officials, industry, local government and the consumer.

Dr. Rene Dubos warned us in prior hearings, and I quote:

> We must abandon, in fact, the Utopian hope that regulations can protect us completely from all health dangers in the modern world.

We are aware that objectivity in human health matters is very difficult to maintain. None of us wishes to err in the wrong direction. Recently environmental quality has also generated an emotional response in the public. There is a widespread public opinion that we should no longer sacrifice aesthetic values or threaten the health of living things in the pursuit of technological achievement and economic gain.

I am particularly concerned with impacts on the environment which may be irreversible and very difficult or costly to fix up if waste management is not proper.

Balancing this somewhat intuitive feeling is the knowledge that pollution control means expense and change, even disruption, for a highly technical society. Unnecessary changes stemming from unfounded fears would divert dollars and effort from other vital national programs.

In a sense we want to have our cake and eat it, too. It is up to science to tell us how close we can come to this optimum. We realize that environmental effects cannot be known with the certainty of a surveyor's trajectory to the moon, but confidence can be increased that decisions and pollution control are well justified by the facts.

Today's witness, Dr. John T. Middleton, who is Director of the National Center for Air Pollution Control, Public Health Service, Department of Health, Education, and Welfare, is particularly well qualified to give us advice, to give this committee some basis on which to work in this particular field.

We are happy to have you here, Dr. Middleton. I wish you would come forward with your assistants and, if you would be kind enough to identify them for the record, please.

Dr. MIDDLETON. Thank you.

Mr. DADDARIO. It might also be well if Dr. Walter Hibbard, Director of the Bureau of Mines, comes forward at this time.

Proceed, Dr. Middleton.

(The biographies of Dr. Middleton, Dr. Ludwig, and Dr. Blomquist follow:)

DR. JOHN T. MIDDLETON

John T. Middleton, Director of the National Center for Air Pollution Control, was Professor and Director of the University of California State-wide Air Pollution Research Center at the time of his appointment to the newly-created National Center on January 1, 1967.

Born in Illinois in 1912, he received his education in California, where he was awarded his B. S. degree from the University of California, and Missouri, where he received his Ph. D. from the University of Missouri.

Dr. Middleton has taught and conducted research in mycology and plant pathology at the University of California at Los Angeles and at Riverside. His pioneer studies of the environment as a regulating factor in disease development in agricultural crops enabled him to first recognize photochemical air pollution as an adverse economic factor to California agriculture in the mid-1940's.

Dr. Middleton has served as Chairman and member of the California Motor Vehicle Pollution Control Board since its inception in 1960 as well as on the Governor's Interagency Committee on Air Pollution and the Executive Task Force on Waste Management.

He has at various times served as a consultant to the U.S. Public Health Service, the National Advisory Committee on Community Air Pollution, the Executive Office of the President and the Office of Science and Technology, and to the World Health Organization. As an adviser he has provided assistance to several European and American Governments in the evaluation of air quality and the development of air pollution control programs.

Dr. Middleton has been a member of the Air Pollution Control Association since 1960 and has served on its Technical Committee on Agriculture and the Standing Committee on Publications. He has also represented the Association on the Committee for Continuing Education of the Engineers Joint Council.

Dr. Middleton is a member of a number of professional associations and societies including American Association for the Advancement of Science, American Chemical Society, Air Pollution Control Association, Netherlands Plant Pathology Society, and the Society of Sigma Xi. An author and lecturer, he is a recognized international authority in the broad field of air pollution.

DR. JOHN H. LUDWIG

PRESENT POSITION

Associate Director for Control Technology Research and Development Programs, National Center for Air Pollution Control, U.S. Public Health Service, Washington, D.C. The Control Technology Programs comprise about 200 research scientists, engineers, meteorologists and supporting personnel. Areas of interest include chemistry and physics of atmospheric pollutants, engineering with respect to technology of pollution control and meteorology.

PROFESSIONAL BACKGROUND

(*a*) 1955 to present: National Center for Air Pollution Control, U.S. Public Health Service

(*b*) 1951 to 1955: Division of Water Pollution Control, U.S. Public Health Service

(*c*) 1949 to 1951: Consultant in Sanitary Engineering

(*d*) 1934 to 1949: Structural and hydraulic design engineer on water resources development projects for the U.S. Bureau of Reclamation and the Corps of Engineers, and service with the Army Air Forces as a meteorologist in Greenland.

EDUCATION

B.S. in Civil Engineering, University of California, 1934; M.S. in Civil Engineering, University of Colorado, 1941; Meteorology Training, New York University 1943–44; M.S. and Sc.D. in Industrial Health, Harvard University, School of Public Health, 1956–57.

ORGANIZATIONS

Air Pollution Control Association, American Meteorological Society, American Public Health Association, American Society of Civil Engineers, Registered Professional Engineer in States of California and Oregon. Member of Phi Beta Kappa, Tau Beta Pi, Chi Epsilon, Sigma Xi, Delta Omega. Diplomate of the American Academy of Environmental Engineering.

EDWARD T. BLOMQUIST, M.D.

Dr. Edward T. Blomquist is Associate Director, National Center for Air Pollution Control, Bureau of Disease Prevention and Environmental Control, U.S. Public Health Service.

A native of De Kalb, Illinois, Dr. Blomquist received his M.D. degree from the University of Chicago and his degree in public health from the University of Michigan. Since his internship at the Marine Hospital at Seattle, Washington, he has been a commissioned officer in the Public Health Service. He was on sea duty with the Coast Guard during World War II and afterwards served with the state health departments of Oregon and California. He became Chief of the State Aid Branch of the Division of Tuberculosis in 1948 and Assistant Chief of the Division in 1949.

Dr. Blomquist was appointed Medical Officer in Charge of the Arctic Health Research Center in Anchorage, Alaska, in 1951. There he directed both basic and applied research on problems of public health peculiar to low temperature areas.

After completing his Alaskan tour of duty in 1954, he became Chief of the Federal Government's Tuberculosis Program, a position he held for eleven years. He joined the Public Health Service air pollution program in January 1965 as Assistant Chief, Division of Air Pollution, and under the newly organized National Center for Air Pollution Control he is Associate Director for Standards and Criteria Development. In this capacity he directs work on health and other effects of air pollution.

Dr. Blomquist is a member of the American Medical Association, the American Trudeau Society, the American Association for the Advancement of Science, and the American Public Health Association.

STATEMENT OF DR. JOHN T. MIDDLETON, DIRECTOR, NATIONAL CENTER FOR AIR POLLUTION CONTROL, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; ACCOMPANIED BY DR. JOHN H. LUDWIG, ASSOCIATE DIRECTOR FOR CONTROL TECHNOLOGY, RESEARCH, AND DEVELOPMENT, AND DR. EDWARD T. BLOMQUIST, ASSOCIATE DIRECTOR FOR CRITERIA AND STANDARDS DEVELOPMENT

Dr. MIDDLETON. May I present my Associate Director for Control Technology, Research and Development, Dr. John H. Ludwig, and my Associate Director for Criteria and Standards Development, Dr. Edward T. Blomquist.

Dr. HIBBARD. I have with me my Assistant Director for Mineral Research, Dr. Harry Allen.

Mr. DADDARIO. We are happy to have you all here and we are happy to have you, Dr. Middleton.

Dr. MIDDLETON. I am pleased to have this opportunity to discuss with you the activities of the Department of Health, Education, and Welfare in the area of air pollution research and control. In the period since your 1966 hearings on environmental pollution, important new dimensions have been added to the Department's air pollution program. I am referring, of course, to the enactment of the Air Quality Act of 1967, which became law last November 21 and which is destined to have a profound influence on all the air pollution research and control activities of government and industry for many years to come.

The enactment of the Air Quality Act marked the start of a new era in the Nation's attack on the growing problem of air pollution—an era in which the knowledge we already have about this problem and its prevention and control will be systematically and scientifically applied in all parts of the country, while at the same time, a greatly increased effort will be made to develop the additional knowledge we must have if we are to prevent the air pollution problem from continuing to grow and worsen.

The Air Quality Act offers no shortcuts to effective control of air pollution. There is no shortcut to the solution of such a complicated problem. Air pollution is a byproduct of all the major growth factors of modern society; it is rooted in the way we build our cities, the ways in which we provide transportation for ourselves and our goods, the ways in which we derive energy from our fuel resources, the ways in which we produce and use a multitude of goods and services, and the ways in which we dispose of all the leftovers of modern life. The effects of air pollution are diverse and often subtle. Polluted air contributes to human sickness, disability, and premature death; it soils and damages buildings and materials of all kinds; it injures and destroys farm crops and other vegetation; and it blights our cities and degrades the quality of our lives.

A problem such as air pollution, which has such far-reaching economic, social, and technological ramifications, must obviously be attacked along a broad front. The solution does not lie only in the enforcement of laws and regulations or only in the application of engineering techniques or economic formulas. Achieving effective control of air pollution will require a combination of these approaches and many others. Moreover, it will require the combined efforts of all levels of government and all segments of industry.

In the 4 years since the enactment of the Clean Air Act of 1963, the Nation has made progress in the fight against air pollution. Federal grants have helped to produce an unprecedented expansion of State and local governmental control programs. Federal abatement action has paved the way for State and local agencies to join the Federal Government in attacking interstate air pollution problems in several places, including the National Capital area.

National standards have been adopted for the control of air pollution from new motor vehicles, thus extending to the entire Nation the initial benefits of technological progress in dealing with one of the most important aspects of the total problem of air pollution.

Finally, the increasing emphasis placed on control action during the past 4 years has served not only to bring a few more sources of air pollution under control, but also, and more significantly, it has helped to stimulate a greatly intensified effort to develop new and improved control technology—an effort which has already begun to bear fruit, particularly with respect to motor vehicle pollution and sulfur pollution arising from fuel combustion.

But there are still many gaps remaining to be filled. Our scientific and technical knowledge in many areas is still incomplete. We need more complete information on the importance of the many pollutants whose adverse effects are not as readily apparent as are the effects of such common contaminants as the sulfur oxides, photochemical smog, and visible particulate matter. Economic data on the impact of air pollution and the costs of controlling it are still not as precise as we would like them to be. Needs for manpower must be better defined and plans made for meeting them. Above all, since air pollution is inherently a regional problem, we must make certain that we attack it on a regional basis.

The Air Quality Act of 1967 was developed in full awareness of how comprehensive an effort it will take to achieve truly effective control of air pollution in this country. This new legislation is a blueprint which, if properly employed, will allow us to correct all the important deficiencies in our current control efforts—the gaps in our scientific and technical knowledge, as well as the inadequacies in our application of existing knowledge.

The Air Quality Act sets up a research and control system which will be coordinated at the Federal level but will involve a high degree of participation by other levels of government and by all segments of industry. I will take just a few minutes to explain, without going into great detail, how the Air Quality Act will affect air pollution research and development activities in the months and years ahead and, more importantly, how these activities and control activities are interrelated and interdependent.

Air pollution, as I have already said, is inherently a regional problem, simply because the air, whether polluted or not, flows freely across the boundary lines that divide States and cities. This means, of course, that in most, perhaps all, places where air pollution is a problem, effective control action will require the coordinated efforts of numerous local governments and, in many instances, of two or more States. This is fully recognized in the Air Quality Act.

One of the chief purposes of the act is to insure that State governments, in cooperation with municipal and county governments, will develop and apply air quality standards on a regional basis in all parts of the country. Toward this end, the Department of Health, Education, and Welfare will designate air quality control regions, each of which will consist of a group of communities that share a common air pollution problem. Air quality control regions will be designated on the basis of such factors as meteorology and topography, jurisdictional boundaries, and the extent of urban-industrial concentrations.

States will not actually be obligated to begin developing air quality standards for any pollutant until the Department of Health, Education, and Welfare publishes air quality criteria for that pollutant and information on available control techniques applicable to the various sources of that pollutant. Air quality criteria will describe the effects of air pollutants on health and property. They will reflect the best available scientific knowledge, even though that knowledge may not be as complete as we would like it to be. The information we will publish on control technology will identify the best techniques available for reducing pollutant emissions at their various sources, whether those techniques involve the application of control equipment, changes in fuel used or industrial processes, or any other practical approach. Since air quality criteria and information on control technology must be published before States can be called upon to begin developing air quality standards, the Air Quality Act must clearly be implemented as fully as possible on the basis of the best scientific and technical knowledge already available, while at the same time, an expanded research effort is undertaken to fill the gaps in this knowledge. Any other course would inevitably result in a slowdown of the Nation's efforts to deal with a problem that is already serious and threatens to reach critical proportions all too soon.

Mr. DADDARIO. At this point your statement appears to support the idea that States should not act at the present time, and that they ought to wait until you establish this criteria.

What arrangements have you made in order to allow States which do have the capability, even though such criteria do not presently exist, to move ahead?

Dr. Middleton. Mr. Chairman, the Division of Air Pollution, recently changed to the National Center for Air Pollution Control, for many years has advocated, in research programs, the development of knowledge which would allow States to move in the area of exercising control of those pollutants they recognize as important adverse factors affecting the public health and welfare.

There are several States in the Nation that have moved in this direction and have adopted ambient air quality standards.

There are many States which contain areas of pollution of some magnitude which have not adopted such standards.

The thrust of the Clean Air Act amendments is to assure that all States become involved in protecting the health and welfare of the people. It is neither the purpose of the Clean Air Act to deter States from moving forward in those areas where they can nor to slow down States that wish to move rapidly to protect their citizens and their property.

Mr. Daddario. But that does run counter to your statement where you say, "Since air quality criteria and information on control technology must be published before States can be called upon to begin developing air quality standards." You appear to be putting yourself in a position where the States which wish to go ahead are impeded, and those which do not necessarily want to need not be pushed in that direction. Nor do you have any way to motivate them to begin sooner rather than later.

Dr. Middleton. It would appear that way but it is not.

Mr. Daddario. Tell me why.

Dr. Middleton. It would appear to delay action at the State level. These new amendments to the act state that the criteria that are to be published must be properly understood and that the mere publication of criteria does not herald the immediate establishment of standards without some additional information.

Many standards that are adopted in States often are adopted as goals rather than something that is to be legally met; and very often control techniques may not be available to meet the standards States adopt. In an effort to correct this, the amendments to the Air Quality Act bring about two kinds of additional knowledge designed to enhance the capability of States to actually carry out the standards they adopt.

In this regard, you can see they are not inconsistent.

Mr. Daddario. Is there any danger that a State which is aggressive and which does move ahead may find itself in the future, perhaps, in a position where its criteria deviates somewhat from that which you have developed, running counter to any aid and assistance which you would give, and be penalized as a result?

Dr. Middleton. I can see the possibility of this. I think it is rather unlikely because the law permits States to have more stringent standards, if they so elect; and there is an opportunity for the Secretary of the Department of Health, Education, and Welfare to make a finding about the suitability of these standards.

Mr. Bell. I think what the chairman is thinking of is your statement on page 7, of your prepared statement, which would indicate that you would preclude a State which wanted to be aggressive from being aggressive.

A good example is my own State, California, Los Angeles in particular, where they really have a crying need for some immediate action.

If they were to sit around and wait for some criteria which you would send out and they were therefore precluded from acting, this could be quite a difficult problem.

I think that is what the chairman is trying to state. Is that not right?

Mr. DADDARIO. I am really interested in Dr. Middleton's approach to this. I do think the record should spell out how flexible your approach will be in States such as Mr. Bell's which do wish to move ahead aggressively at this time. If they do find themselves in disagreement, perhaps you should have a very flexible approach to this, and they would not be penalized.

I think it is important that there be action as long as this is not capricious action.

Dr. MIDDLETON. Mr. Chairman and Mr. Bell, having been a former Californian and also the chairman of the motor vehicle control board in that State, and having had some concern about the quality of air in that State, I felt what I had learned there perhaps could be applied in other places. I think this piece of philosophy should suggest to you that the Federal Government does not propose interfering with progress at the State level, but to do all it can to enhance a more rapid and aggressive attack on air quality throughout the Nation.

Mr. BELL. I appreciate very much your statement.

Dr. MIDDLETON. I hope I have answered your question; perhaps I have not responded to your satisfaction. I would be glad to try further.

Mr. DADDARIO. It is difficult for you to establish the exact path which we will follow in the future. What we are trying to do here is to find out what your present intentions are and how flexible you are for the future.

The opposite end of this discussion gets to the States least aggressive and not anxious to move ahead. You say they cannot be called upon really to begin developing these standards until you do publish criteria. Is there any informal program going so that they might be stirred to do something in accordance with your advice and assistance?

Dr. MIDDLETON. Yes; there is much going on. The remaining portions of my testimony, I think, will bear further on that.

I think the most significant single event that assures that more is being done than would appear to be done, is that of our abatement and control activities in which, where there are serious air pollution problems today, and the Secretary has, in consultation with the Governors of the affected States brought about air pollution consultations, the Center has subsequently called abatement conferences for the purpose of controlling air pollution.

Beyond the abatement conference protocol, we have the control agency development program which is designed to aid States, municipalities, and local governments in developing air pollution control programs on a matching fund basis. So, it is through the development, the identification of air pollution problems at the local level, and by the initiation of air pollution control programs at local and State levels that the Center has already aided States in moving forward toward setting air quality standards and providing them with technical assistance to research State goals in advance of Federal promulgation of air quality criteria.

I pick out this important example of a very aggressive attack, with significant funding, designed to achieve air pollution control through aid to the States.

I think this may satisfy the questions and suggest we proceed.

Mr. **Daddario.** You go ahead and we will break in wherever we feel it is necessary.

Dr. **Middleton.** The publication of air quality criteria for a pollutant and information on applicable control technology will be the signal for States to begin developing air quality standards for that pollutant and detailed plans for implementation of the standards in air quality control regions that have been designated by the Department of Health, Education, and Welfare. Air quality standards will prescribe limitations on ambient air levels of pollutants in a region; since the fundamental purpose of setting such standards is to provide for the protection of public health and welfare, State governments will be expected to consider, among other things, the air quality criteria that have been published in accordance with the Air Quality Act. States will also be expected to take into consideration the published information on control technology.

The Air Quality Act sets up a timetable which States must follow in developing air quality standards and implementation plans, and requires that the standards and plans be reviewed by the Department of Health, Education, and Welfare. In addition, the act prescribes the procedures to be followed in the event that a State either fails to meet its obligations or submits standards which are not consistent with the provisions of the act.

And finally, the act makes it clear that States will be expected to assume the major responsibility for seeing that their plans for implementation of air quality standards are carried out. If action by a State proves inadequate, however, provision is made for enforcement at the Federal level.

I indicated, a few moments ago, the importance of research to expand and improve our knowledge of the adverse effects of air pollution and of ways to prevent and control it. The Air Quality Act provides for a substantially accelerated research effort, with special emphasis on finding new and improved ways of dealing with the complex and very serious problems associated with motor vehicles and the use of sulfur-containing fuels.

We will, of course, expand the work being done in our own facilities and in those of other Federal departments and agencies. But we will have to rely, too, on the many industries that are capable of contributing to the search for practical solutions to the various technical problems involved in controlling air pollution; indeed, we have already begun moving toward much greater utilization of the resources of industry.

The Air Quality Act also provides for continuation of many of the activities initiated under the Clean Air Act of 1963. One of these activities is the abatement of interstate and intrastate air pollution problems; this activity, as I have already noted, has been productive in several places in the country.

In addition, the Air Quality Act provides new authority for court action to curtail pollutant emissions in emergency situations—that is, when adverse meteorological conditions threaten to produce an episode of extraordinarily high air pollution levels in any place in the country.

Mr. **Daddario.** What criteria have you established to come to this conclusion so that the Secretary may take steps? What forces him to make a determination that there is going to be an episode of extraordinarily high air pollution? How can he forecast it early enough and move quickly enough in the courts. What criteria will the judge have before him in order to come to a conclusion since you have already said that the establishment of this criteria is presently too tenuous?

Dr. **Middleton.** I don't believe I suggested the establishment of criteria as tenuous. I think the relationship of criteria to standards, and the fact that air pollution control is the responsibility of State and local governments is the thrust I have been trying to present to you and the role of the Federal Government in being certain that the information that is available is categorized and cataloged so that it can be properly used.

In the event it is not used or, in the event it fails to work, then there are other courses of action. It is to this point I now speak in the case of emergency actions.

Mr. **Daddario.** I understand that and I am not trying to get into any argument with you, Dr. Middleton. What we are trying to do here is to see how this works. We know we must come to some judgment sooner or later on criteria and this has to be based on better information than we presently have available. Therefore, there needs to be a lot of work done. We are trying to arrive at a judgment; how long it will take us to get to the point where we do have criteria. I wonder, since you bring up this episodic situation, and because there is uncertainty, what is the emergency control which the Secretary can put into effect under these circumstances?

How do we know there will be such an episode? What criteria presently exist which will establish a set of facts early enough for us to say that 5 days or 10 days from now this will happen? How do you then get into court in order to get a judge to know enough about this so that you can explain it to him in such a way that he can recognize what the criteria are?

Dr. **Middleton.** If it is your pleasure to have this subject discussed at this time I will be glad to do so. Since we are dealing with emergency actions, which is a specific part of the law; namely, section 108(k), I would like to call on Dr. Ludwig to answer the first part of your question which relates to the prediction systems developed and how they are employed.

Mr. **Daddario.** Is that section 108(k) or 208(k)?

Dr. **Middleton.** I will give the exact citation.

Mr. **Daddario.** Just so the record will be straight.

Dr. **Middleton.** If you have a copy of the law before you, you will find it on page 13. It is section 108(k) and it relates in its entirety to your particular question of air pollution episodes.

Mr. **Daddario.** I think it would be fine if Dr. Ludwig can go ahead and go into this at this time.

Dr. **Ludwig**. Yes, Mr. Chairman. What I would like to comment on is the prediction system as it applies to the meteorological aspects. In the National Center over the last 10 years there has been developed, in cooperation with the Environmental Sciences and Services Administration, a system where every day we determine and carry, over the U.S. Weather Bureau network, a warning system termed "an air pollution potential advisory."

What these do is designate large areas of the country where the ventilation of the atmosphere is very minimal. This is both in the vertical and in the horizontal. Essentially it is concerned with low horizontal sweep of the air out of the region and a very limited mixing depth where the pollutants can mix vertically into the atmosphere.

Mr. **Daddario**. What is the mechanism through which you establish this?

Dr. **Ludwig**. This is done at the present time by the U.S. Weather Bureau in Suitland, Md. It is done by professional meteorologists.

Mr. **Daddario**. Is this information made available to you on a daily basis?

Dr. **Ludwig**. Yes. This information is transmitted by a teletype network and is made available to all major Weather Bureau stations in the whole country. This has already been set up.

In addition to this, at the present time, in some of the major communities of the Nation we have additional meteorologists who are working on schemes which will further improve on this locally. This is the second thing that is going on.

Mr. **Daddario**. Are they also U.S. weather people?

Dr. **Ludwig**. Yes. These are Environmental Science and Service Administration people who have been assigned to the National Center and who work as a portion of the National Center for Air Pollution Control.

Mr. **Bell**. Does this work throughout the country as a coordinated effort, or just in this area here?

Dr. **Ludwig**. This service goes on all over the country for the whole continguous 48 States.

Mr. **Bell**. You are talking about predictions. What kind of a timelag do you have on this?

Dr. **Ludwig**. At the present time we are predicting the continuation of low-ventilation potential for a period of 36 hours.

At the present time, also, we are attempting to improve this system so that we can predict it on a 12- to 24-hour period in advance.

Mr. **Bell**. Then you would be able to have information back here that tomorrow morning in Los Angeles, for example, you will have a smog alert. Is it that type of thing you are talking about?

Dr. **Ludwig**. That is right in part. We issue air pollution potential advisories. These advisories do not predict air pollutant concentrations per se but rather meteorological elements which, when combined with source configurations, can lead to a buildup of pollution in an area.

Mr. **Bell**. What is your degree of accuracy? Have you checked that out?

Dr. **Ludwig**. Yes. We have issued advisories for most all of the major air pollution stagnation conditions, for instance, the one which occurred Thanksgiving a year ago in the eastern seaboard. At the present time, yesterday, an alert went out for the area in the southeastern part of the country. This covers the area of northern Florida, Georgia, South Carolina, and so on.

Mr. **Bell.** You must have coverage in Los Angeles, too?

Dr. **Ludwig.** Yes.

Mr. **Bell.** How accurate have you been there?

Dr. **Ludwig.** We have been very accurate in this location, also. I want to make one thing certain. What we are predicting is the stagnation of the atmosphere. This does not necessarily coincide with the formation of photochemical smog which has some additional input to it.

Mr. **Daddario.** What are you alerting the people in north Florida to do? You put this together. You have alerted them. Now what happens?

Dr. **Middleton.** What happens at this point is a matter of considerable concern to the Secretary of the Department, and in our efforts to implement this section, since this is a new provision of the law, we have assembled in the Center an emergency task force which is concerned solely with emergency actions.

It is headed by the chief of the abatement program, Mr. William Megonnell; he is now in the process of developing, Mr. Chairman, the details that will be required to actually bring about an effective emergency action to control episodic air pollution events.

Since the problem becomes a local one, and effective control can be achieved only at the local basis, we are developing the kinds of criteria—and I use the word to mean the elements involved—which will tell local control officials the levels of pollution their monitoring system should be sensitive to, and to bring about an action to curtail recognized sources of pollution.

These are some of the kinds of items involved in emergency action planning; the finite detail is not now available.

Mr. **Daddario.** Would this include sufficient information so that you could come to some judgment about the effect this might have on people who are suffering from respiratory illnesses? Would you then give advice to the local people that they should move such people out of a zone? Are these the types of things you are concerned with?

Dr. **Middleton.** There is a proposal now being considered in the New York area in which the Center is looking toward taking care of the difficult health cases you speak of by providing them with special medical attention, such that hospitals may be alerted and be on the watch for people who are in either poor health or in nursing homes and who may need special attention.

Mr. **Daddario.** This brings us to the criteria again, Dr. Middleton. How do you know what type of smog conditions do in fact effect people with respiratory illnesses? Are you guessing at it? At what level would you put up a danger flag so such a serious step could be taken?

I would expect that sometime there will develop such a serious condition and you would have to make recommendations to local authorities.

Dr. **Middleton.** We are quite prepared to do this with the State and local governments involved, of course. The criteria concerned are the ones we were beginning to speak about but which we have not completed because I have not been able to finish my testimony.

Some of the organizational materials on these charts would help you to see how this comes about. If it is your pleasure that I be responsive at this particular time, I should say we know quite a bit about many pollutants. We know much about particular ones. There are some we do not know as much about as we would like. But the ones that have adverse effects on health have been known for some time; and we are improving our knowledge of them. For those pollutants for which we have information, such as the oxidants, sulfur oxides, and some particulate matter, we recognize adverse health levels. We have published criteria on sulfur oxides already; we shall reevaluate them in time. We are in the process of publishing other critieria as reported to the Senate Public Works Committee.

At this time I would like to call on Dr. Blomquist, a doctor of medicine, to comment further on our health criteria.

Mr. DADDARIO. Why don't we come to that after Dr. Ludwig finishes his statement? I think it is important that he does explain the way in which you are developing a system of meteorological knowledge. Then we will come to Dr. Blomquist.

Mr. RYAN. Mr. Chairman, I would like to go back to the question you asked because it is a very key question. That is, do you now have a system so that when you issue an air pollution advisory, some action follows in the local government? I ask this question because in November 1966, at the time of the Thankgiving Day inversion in New York City, you did predict the stagnation of the air and all the conditions that led to that inversion. You predicted it some 24 hours before it happened, as I recall. Yet, New York City and New York State did nothing. It was 24 hours after Thanksgiving Day, when it started, that New York City issued the first alert, 48 hours after you had given them notice. New York City received the warning on Wednesday, November 23 at 12:07 p.m.; the official alert was issued on Friday, November 25 at 1:15 p.m.

What are you planning to do in the future to get action at the local level? It is all very well to be able to predict the episode. It is more important, if the local government fails, that you, with your knowledge, take action so that the people in the local areas are protected. There was a 48-hour time gap between the issuance of the air pollution advisory and the first public alert in New York City, which is inexplicable, over Thanksgiving Day. If it had not been for the fact that it was a holiday, we would have had a great deal more than the 168 excess deaths which occurred during that period.

Mr. DADDARIO. Following what Mr. Ryan just said, I think it gets back to the point that I just touched on. At that stage of the game could you go to court to force the local government to do something?

Dr. MIDDLETON. I am suggesting that the local government itself wishes to do something. I am suggesting that the State of New York and the city of New York wish to do something. The difficulties of integrating air monitoring and the recording of information on pollutant concentration, the difficulties in identifying the specific sources of the principal pollutants are the items that the local control agencies need to stipulate; such as the air pollution potential predictions come and the levels of pollution begin to rise, there can be agreement in the New York-New Jersey metropolitan area that when selected pollutants reach a certain threshold there shall be a stipulated course of action to control those sources.

This course of action that you asked me to describe is not now describable. We are in the process of enumerating, because of the knowledge we have from the basic abatement conference, the principal pollutant sources. We are attempting through the conference recommendations to actually abate those sources in order to forestall having to call for emergency action.

Mr. Ryan. I understand that, but assume that today you issued an advisory notice such as you did on November 23, 1966, what would you do today to avoid a repetition of what happened in 1966, Thanksgiving Day? What would you do now? With all due respect, I do not want to hear about plans for the future which are still to be worked out, but what specific action would you take today?

Dr. Middleton. Our specific action would be to go to the New York area with the man in charge of these emergency actions in the event of this prediction, and to pick up the points you enunciated. Let us assume that we have the prediction that in 24 hours there will be an alert situation. We then see its validation. The air monitoring networks suggest the level of sulfur oxides is rising, and when they rise to some threshold level, some specific number, then a course of abatement action must take place. This course of action is the responsibility of the local air pollution control agent.

Mr. Ryan. Suppose it fails to take action.

Dr. Middleton. If the local group fails to take action, then the Secretary can call upon the Attorney General to ask for a cease and desist order to abate this particular nuisance, this particular problem, this particular disastrous source of pollution affecting the health of persons. It is because we may need a more rapid control action than this that we wish to be assured that the State and local officials in fact do have an implementation control plan and that it is workable. That is why through our control agency development program, when we award matching funds to the city and State of New York, as an example again, Mr. Ryan, we want to be sure that in their workable plan there is a scheme, a plan, which will bear directly upon the new provisions.

Mr. Ryan. Do they have a workable plan today?

Dr. Middleton. I do not know whether Mr. Heller, the Commissioner in that area, now has a workable plan. I believe one is in formation, and I am sure that he expects the important pollution elements to be controlled at that time.

Mr. Ryan. I would think that over a year later there would be a workable plan in effect, and not one in formation. I would hope that your agency would see to it that one is developed as rapidly as possible because we face, in New York, at any time a similar emergency situation.

Mr. Daddario. Dr. Middleton, following again Mr. Ryan's question, if we ran into an emergency situation, could you, for example, establish a procedure under the law as it presently exists to prevent all traffic from moving to the city of New York if this situation were deemed to be dangerous enough? How would you do it?

Dr. Middleton. Dr. Blomquist suggests that the city of New York already has a plan of this kind in mind, but if the city of New

York failed to actuate this plan and carbon monoxide, for example, were the principal element, then the Secretary would be able to ask the Attorney General to go to the Federal district court and see that this source of pollution was controlled.

Mr. DADDARIO. Dr. Ludwig's statement indicates that you are developing the kind of system in which you can have confidence if an emergency of this kind does come about. You would have a system which can work without scaring everybody half to death.

Dr. MIDDLETON. To have the predictability, the capability of a high percent win, saying, "Yes, this is the event," so we can begin in advance of the rising levels of pollution, as Mr. Ryan well knows occurs, before they really get up to certain points, if we have the assurance this thing will last for 36 hours, that we have the assurance that it would be in the interest of the public health and welfare to begin throttling sources of pollution, then an effective emergency action can be achieved.

But when we get to the necessity of describing the specific course of action, I am unable now to give you the precise detail of this action. I believe this is the responsibility of State and local governments to work out. It is the responsibility of the Federal Government to see that there is a workable plan so that the Secretary may act with dispatch and confidence of success.

Mr. DADDARIO. A workable plan upon which local and State governments can proceed confidently.

Dr. MIDDLETON. Yes.

Mr. RYAN. I would strongly suggest, instead of New York City having a plan in mind, that it have a workable plan in being. I wonder if you would be willing to set a timetable right now as to when you expect New York City to submit to you a workable plan, because I do not think we can permit this situation to go on any longer.

Dr. MIDDLETON. When I said plan, I was thinking not of a scheme or an idea, but in fact what you have enunciated.

Mr. RYAN. Right.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. No questions.

Mr. DADDARIO. Mr. Bell?

Mr. BELL. Dr. Middleton, you said something to the effect that in Los Angeles the major problem of pollution was motor vehicles. Do you know of any major cities throughout the country where the major problem is not motor vehicles?

Dr. MIDDLETON. Putting your statement in the negative, no. The motor vehicle is the largest single source of pollution throughout the Nation; perhaps 75 percent.

Mr. BELL. Then the answer to Mr. Daddario's question would have to be something in the order of control of motor vehicle movement, is that right?

Dr. MIDDLETON. The motor vehicle produces several kinds of pollutants. Power generation produces other kinds of pollutants. Depending upon the nature of the city, its economy, its sources of pollution, therefore, one needs to control various pollutants to different levels.

That gets back to the regional aspect. So, in Los Angeles, as an example, where many of the stationary sources have been very well controlled, this isolates the automobile as being one of the more significant sources. In other areas where stationary sources of pollution have not been so well controlled, the automobile may not be so overwhelmingly important.

Mr. BELL. As far as you know, in the type of situation which Mr. Ryan just described, does Los Angeles have a workable plan that can be brought into action?

Dr. MIDDLETON. Los Angeles takes pride in its alert system and its course of action and the fact that they have developed something that they believe works well. It has been tried and tested at low levels, and I am quite sure they are hopeful they will never have to try it at the high levels because the ultimate relief is to expect the State to move in and take care of the local problem.

The issue here is, over the years since there has been an air pollution control district in Los Angeles since 1947, that they have had considerable time to evolve the kind of program required to protect the health and welfare of persons and property in the area.

Mr. BELL. It is your feeling that Los Angeles has one of the better plans?

Dr. MIDDLETON. They have one of the workable plans. I am sure that even in Los Angeles they feel the plan can be improved.

Mr. BELL. I would certainly think so. I was caught out there in November and the smog in Los Angeles was quite sickening, really. It is a terrible situation.

Dr. MIDDLETON. I think you would be very happy, then, to learn about the proposed new regulations the Department of Health, Education, and Welfare has published in the Federal Register, as I had expected to mention in my testimony, making the standards and requirements, the emission standards of the motor vehicles, the sole responsibility of the Department of Health, Education, and Welfare, more stringent, better to cope not only with the Los Angeles problem, but with the growing problem of carbon monoxide, a very important factor in the pollution in New York City. We must proceed with dispatch to better the control of motor vehicles wherever they are.

Mr. BELL. I certainly concur in this. When Mr. Ryan speaks of his city, I can speak with double emphasis for Los Angeles.

Mr. MOSHER. Is this plan in Los Angeles one which provides for the instant or immediate use of police power to forbid the movement of cars and that sort of thing? What is this plan? In other words, when an emeregency arises, can the local authorities in Los Angeles stop traffic and require people to keep their cars in their garages and not use them?

Dr. MIDDLETON. Mr. Megonnell suggests that the most workable part of their plan, their scheme of action, is that which is related to the stationary sources, in which they have an alert system and a radio communications system and key men identified in certain key industries that would be responsible for controlling sources of pollution. At the time levels approach specific concentrations, then the Los Angeles Air Pollution Control District through its radio communication with the identified sources says, in effect, "We expect this pollution to continue for such and such a period of time; we call Alert 1; you are to proceed with your predetermined control action." The action is very specific. I regret I do not know the specific detail.

Mr. BELL. But they can stop cars?

Mr. **Mosher**. You already said the stationary sources were not the prime source.

Dr. **Middleton**. I said in Los Angeles they have been very well controlled, and the motor vehicle in that area was relatively more important.

Mr. **Bell**. What about the motor vehicle? You do have a program to stop the motor vehicle; is that correct?

Dr. **Middleton**. The higher levels of alert in Los Angeles are such that the Los Angeles County Air Pollution Control District calls upon the executive power of the Governor's office to prescribe the needed additional actions.

Mr. **Bell**. What are those additional actions?

Dr. **Middleton**. As I understand—and I may be wrong in these specific numbers, and if I am incorrect, I would like to have the record changed——

Mr. **Daddario**. You may, of course, correct the record.

Dr. **Middleton**. When the ozone level approaches either 1 or 1½ parts per million instantaneous reading, then the county of Los Angeles advises the Governor of this alert situation and invites State support to control the local problem. This then is the force for abating the motor vehicle movement. Los Angeles County itself, as I understand it, does not do this.

Mr. **Bell**. What can result from that if you stop the motor vehicles?

Dr. **Middleton**. Chaos.

Mr. **Bell**. What would be the result from such actual direct action?

Dr. **Middleton**. The direct action in that case——

Mr. **Bell**. The Governor has been notified and the Governor has this prescribed pattern and makes his statement that we are in this crisis. Then what happens?

Dr. **Middleton**. May I say as a long-term resident of California—this issue has never been settled. I would propose not to settle it before you today. The course of action really is that because the motor vehicle is a State-taxed instrument and the motor vehicle pollution control is a State responsibility, and as such it moves outside of the realm of a county air pollution control action. I believe it is for this purpose that one calls upon the Governor to exercise statewide executive restraints on motor vehicles. I am not at all sure the State has an action plan to curb movement of motor vehicles in Los Angeles.

Mr. **Bell**. In other words, you do not really know whether the Governor of the State of California can act in case the situation requires.

Dr. **Middleton**. I know perfectly well the Governor can act for the protection of public health and welfare. I do not know that the Governor has a plan.

Mr. **Mosher**. It has not been tried?

Mr. **Bell**. It has not been tried, and it has not been revealed to you what his plan would be. It would affect Los Angeles County, obviously, probably as much as any place in California. He actually has not delivered to you a plan of what he would do?

Dr. **Middleton**. I have not learned of this for a number of reasons. I do not say this defensively. On November 21, last, this legislation became law, and I have not had the opportunity of doing more than establishing within my own organization a very important group of people who are responsible as a Task Force for Emergency Actions.

I have not been able in this period of time to develop all the information that would be required to be completely responsive to your question, Mr. Bell.

Mr. **Bell.** Is there a place where I could find out what the action would be?

Dr. **Middleton.** I will find out and will tell you.

Mr. **Bell.** I would appreciate that.

(The information requested is as follows:)

The Los Angeles County Air Pollution Control District adopted emergency regulations in 1954, because of widespread concern that air pollution in Los Angeles might produce disasters similar to those which have occurred in other places in the United States and Europe.

The system set up under these regulations provides for issuance of daily air pollution forecasts by meteorologists of the Air Pollution Control District. Forecasts are based on data on airflow patterns, inversions, atmospheric mixing height, wind speed, and other factors. Forecasts of adverse conditions are brought to the attention of the Air Pollution Control Officer, so that preparation can be made for taking any emergency action deemed necessary.

The District maintains a network of air sampling stations, some of which are operated continuously. Data are telemetered to the District's headquarters, where an around-the-clock communications center is operated.

Following are the alert stages which have been established for toxic air contaminants (in parts per million) in Los Angeles County:

Contaminant	Alert stages		
	1st	2d	3d
Carbon monoxide	100.0	200	300.0
Nitrogen oxides	3.0	5	10.0
Sulfur oxides	3.0	5	10.0
Ozone	.5	1	1.5

Whenever air contaminant concentrations reach prescribed percentages of the first alert values, the District's staff begins intensive monitoring. If a first alert levels is reached, notification by telephone is given to principal air pollution control and police officials of the County; enforcement staff members in patrol cars are notified by radio; mass media and selected industrial sources are notified by telephone or radio; and members of the Emergency Action Committee are advised. There is a general warning to the public to curtail driving and other air-polluting activities; no open burning of any type (even those few fires normally allowed under variance or permit provisions of the Los Angeles regulations) is permitted; and industrial sources are informed that they may have to cease certain operations.

Should concentrations approach second alert levels, a meeting of the Emergency Action Committee is called to determine whether a second alert should be declared. If a quorum of the Committee is not available and second alert levels are reached, the Air Pollution Control Officer is empowered to declare the alert. In addition to the actions undertaken during the first alert, industry is requested to discontinue operations in accordance with pre-arranged and scheduled voluntary shutdown plans. When voluntary implementation is ineffective, the Control Officer is authorized, with advice of the Emergency Action Committee and approval of the Air Pollution Control Board, to require curtailment of industrial activities.

If third alert levels are reached, the Air Pollution Control Board may request the Governor to declare a state of emergency and take actions under the California Disaster Act. To date, no alert has gone beyond the first stage.

As for reduction of motor vehicle traffic during alerts, the Air Pollution Control Officer is required to take all necessary steps, by using the facilities of the appropriate mass communication media, to request the general public to cease all non-essential use of motor vehicles in the Los Angeles Basin and to form car pools when practical. Compliance with such requests is totally voluntary.

In 1955, a committee of scientists, administrators, police, traffic, highway, and air pollution authorities, instituted an investigation to determine whether and how automotive traffic could be controlled during air pollution alerts. All the problems involved in such action were investigated, and after much deliberation, the group reported that it would be physically impossible to stop all or any significant portion of the vehicular traffic in Los Angeles County. This decision was based on conditions that may be unique to Los Angeles County. Public transportation in the County is grossly inadequate, and great dependence is placed on private automobiles. There is a multiplicity of local police jurisdictions, with little overall coordination, and there are not near enough law enforcement officers to cover the many thousands of miles of streets and highways in the County.

Even though it was concluded that, as a practical matter, it would be impossible for the Air Pollution Control Officer to enforce regulations requiring cessation of automobile travel during emergency conditions, plans were developed to assist in voluntary reduction of motor vehicle traffic. A significant element in this program is the encouragement of the use of employee car pools, in cooperation with industrial plants and businesses, during critical smog periods. During such times, business and industrial establishments are immediately requested to urge their employees to travel in car pools previously organized under the leadership of the employer. Cars remaining in company parking lots are protected by company guards. Such measures can remove thousands of automobiles from highways and streets, thereby materially lessening emissions from auto exhausts and greatly minimizing the intensity of smog attacks.

Plans for the establishment, maintenance, and operation of such car pools by employers of large numbers of people have been requested and received by the Air Pollution Control District. Knowledge of the geographic location of the larger masses of automobiles has been used to develop a comprehensive plan embracing the entire Los Angeles Basin, so that, in the event emergency action becomes necessary, it would be possible to request car pooling in areas where critical air pollution concentrations are occurring or can be expected to occur.

Mr. **Ryan**. May I make an observation? As a parochial New Yorker, I thought I would never hear that some other city is ahead of New York. I find it rather inexcusable that New York does not have a workable plan.

Let me urge you, Dr. Middleton, to insist at the soonest possible moment that they come forward with an effective plan, because we face another disaster any day. I think all of us recognize the potential.

Dr. **Middleton**. I can only add, Mr. Ryan, I recognize this—I want to say, perhaps, better than you, but that might be presumptuous. It is because of this emergency that I have attempted to do what we have done, which may seem modest at the moment, but that is only because of its recent action and our first opportunity for acting in this way by specific congressional directive.

Mr. **Ryan**. Prior to the enactment of the Clean Air Act Amendments of 1967, you have had the New York-New Jersey abatement conference procedure available since last January.

Dr. **Middleton**. Yes, we have had other courses of action, but we have not done the specific things that your chairman has very well chosen to emphasize—the need to have a course of emergency action that is not merely a plan but actually a workable one—and that it relates to what the health effects of the pollutants shall be. This, in turn, gets back to your original question: What are the criteria to abate and prevent the air pollution episode?

Mr. **Daddario**. You are presently developing the kind of people who can give help to the State and local governments so such emergency legislation and such emergency action can be taken?

Dr. **Middleton**. This, I can assure you unequivocally, is the case.

Mr. **Bell**. I have one more question, Mr. Chairman.

Dr. Middleton, I was not quite clear on your answer to Mr. Ryan as to what your action would be if a State or locality were told that this situation was occurring. When this situation did occur, when they did not act and when the Federal Government enjoined them to act, no action was forthcoming. Could the Federal Government act?

Dr. MIDDLETON. We would act through the Office of the Attorney General and the Justice Department and see that control took place.

Mr. BELL. In other words, you could actually move in there after the Attorney General acts and bring about whatever changes were necessary—to stop motor traffic, let us say?

Dr. MIDDLETON. Whatever the Attorney General was able to bring forth through the Federal court as an injunctive measure would be that which would take place.

Mr. BELL. I guess that means stop traffic, right?

Dr. MIDDLETON. I am attempting to say I cannot make a judgment for the Federal court.

Mr. BELL. I assume that is right.

Mr. FELTON. I think the question is: Can you move against a class, or do you have to move against an individual? Can you seek an injunction against a class, as all automobile drivers cannot come into the city; or do you have to move against a specific individual or industry, as *x* industry cannot emit certain pollutants?*

Dr. MIDDLETON. Mr. Felton, I am sure you recognize this is a matter of considerable debate in the General Counsel's Office of the Department as well as in the Department of Justice. We are hopeful that the opinion will suggest we move against classes rather than individuals.

Mr. DADDARIO. Dr. Middleton, if we could have Dr. Ludwig continue to spell out how you are putting together this capability and how you intend to work it now from a 36-hour forecast to something on the order of 12 to 24. You are about at that stage of the game.

Dr. LUDWIG. Yes. The present air pollution potential advisories predict the continuation of existing air stagnation condition for an additional period of 36 hours. What we are now attempting to do is to be able to forecast the onset of these events 24 hours in advance and, in addition to this, to quantify it. In other words, to designate when they will start, how long they will last, and the severity of the particular stagnation; for example, weak, medium, or severe. We are trying to make this a better tool for the kind of emergency action that we are talking about.

At the present time we update these forecasts every day. For example, we issue one of these advisories which indicates that stagnation will continue for another 36 hours. The next day we will issue an advisory which says it will either continue another 36 hours or end the advisory after a certain period of time.

These advisories, which go out to all the Weather Bureau offices, are then transmitted to the State and local agencies. Any industries that want to be kept informed, when these advisories are issued, are privileged to notify the local Weather Bureau station and they will be advised that an advisory has been issued for the particular period in a certain area.

The other piece of information, of course, which compliments an advisory, is the air monitoring information that the State and local agencies maintain in their areas. These advisories and a monitoring of the air quality that exists in the area are the basis of the action to shut down what sources, and so forth.

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*See Appendix D, page 583, for an advisory opinion of the Legislative Reference Service, Library of Congress, which indicates that a class action against automobile drivers could not be maintained.

Mr. Daddario. Dr. Ludwig, at the time when you come to the judgment that there is a serious episodic situation developing, do you take extraordinary steps to accent the information? How do you do that? To whose attention do you call it, beyond the Weather people in that area?

Dr. Ludwig. The fact that an advisory is to be issued is called to the attention of the State and local air pollution agencies in that region so they can do special sampling and take other appropriate action if they so desire.

Mr. Daddario. Do you have people available at that time, recognizing the manpower as it exists to be a difficult one, who can give assistance and who are qualified? Do you have people you can move around from one part of the country to another in case it is necessary?

Dr. Ludwig. At the present time we do not have a mobile group to do this. One of the areas being considered by a task force study group is the action that we will take under the new act and the type of organizational setup we need to assist in this kind of operation.

Mr. Daddario. Do you plan the use of a mobile force of this kind?

Dr. Middleton. Yes. In addition to what Dr. Ludwig has told you, Mr. Chairman, in each of the Department's regional offices we have a regional representative who is specifically carrying out the work of the National Center for Air Pollution Control. This, then, is the arm of the Department in the region designed to aid the local agencies in making air pollution control decisions. We have hourly communication with them. While this is helpful, it is not really the answer that we seek for the solution of this episodic emergency problem.

If I could take just a moment to point out the sequence of criteria, the adoption of ambient air quality standards, the State then having a period of time to give the Secretary its implementation plan. It is in the implementation plan that we would except the State to outline in detail what course of action they have planned for emergency action. We are attempting through the new legislation to see that the preventive aspects take place so we can minimize the need for the crash emergency actions. Again, the whole thrust is to be sure that at the State and local government level those political subdivisions understand there is an air pollution problem and that they can do something about it, and that they actually do have a plan to do something about it. This would include, specifically, the emergency actions required.

Mr. Daddario. Dr. Middleton, you may then proceed from where you were or with Dr. Blomquist, as you desire.

Dr. Middleton. If I may finish the last few pages, I think it will give us a little further overview of what the National Center for Air Pollution Control is, what its responsibilities are, and how, if they are marshaled properly, we can prevent episodes and see that we go about preventing air pollution so we do protect the public health and welfare.

Another activity that will be continued is the awarding of matching grants to local, State, and regional governmental agencies to help them create and carry on effective programs for the prevention and control of air pollution. These grants will also be available to assist such agencies in meeting the new responsibilities which will be placed upon them under the provisions of the Air Quality Control Act. In addition, funds may also be made available to support the work of planning commissions set up by States to assist in the development of air quality standards in interstate air quality control regions.

The establishment of national standards for the control of air pollution from new motor vehicles, first authorized by the 1965 amendments to the Clean Air Act, will also be continued. Such standards are now in effect for 1968 model cars and light trucks using gasoline as their fuel. Two weeks ago, we proposed more stringent standards for such vehicles for initial application in the 1970 model year. In addition, standards were proposed for the control of smoke emissions from diesel buses and trucks.

Our activities relating to the prevention and control of air pollution from Federal installations will also continue. There has been marked progress in this work, due in large part to the high degree of cooperation we have been getting from other Federal departments and agencies. For the first time, the Federal Government now has a detailed inventory of air pollution sources at all its installations and comprehensive plans for control action, wherever such action is necessary.

A number of new activities will be initiated under the Air Quality Act in support of the research-and-control system which the act sets up. Among these will be a program for registration of fuel additives, whose use already contributes, and in the future may well contribute even more, to all environmental pollution problems; a study of the need for and effect of national emission standards for major industrial sources of air pollution, with a report to the Congress due 2 years from enactment of the act; a comprehensive study of the economic costs of controlling air pollution, including costs that will be incurred by both government and industry; an investigation of manpower needs in the air pollution field and of needs for training programs; and, finally, a study of ways to control air pollution from aircraft and of the feasibility of establishing national emission standards applicable to aircraft.

In implementing the provisions of the Air Quality Act, we will have opportunities to solicit the advice and assistance of all those segments of the Nation's population who are concerned with the problem of air pollution and who are in a position to help us. The act provides for the creation of a Presidential Air Quality Advisory Board as well as technical advisory committees. The membership of these groups will include State and local officials, representatives of business and industry, scientists, and so on.

This completes my summary of the provisions of the Air Quality Act. This legislation, as I said at the beginning of my statement, opens a new era in the Nation's fight against the threat of air pollution. Exactly how fast our progress in this new era will be will depend heavily on how promptly and effectively all levels of government and all segments of industry pursue the roles they are expected to play. The Air Quality Act binds all levels of government and industry together and provides for us all a comprehensive plan for attacking air pollution; if any of us fails to do his job, the plan cannot completely fulfill the promise it holds. In signing the act, President Johnson reminded us that "It is a law—not a magic wand to wave and cleanse our skies. It is a law whose ultimate effectiveness rests with the people."

A great deal of work must be done to translate the law into action. Air quality criteria must be developed. Air quality standards must be set and enforced. An accelerated research effort must be undertaken. All this and more must be accomplished if we are to stop the rising tide of air pollution and begin to turn it downward. I believe that under the provisions of the Air Quality Act, this can be done. I assure you that the National Center for Air Pollution Control will strive to carry out, as promptly and as thoroughly as possible, all of its responsibilities under the act, so that States, local governments, and industry will have the tools they need to move the Nation toward better control of air pollution.

Mr. Daddario. Dr. Middleton, how do you view the present Federal Agencies' involvement in this? What is the number of agencies which deal with pollution in one way or another? How are they being brought together? Should there be some more concentration of this activity under one agency or a special agency?

Dr. Middleton. I think you can see, Mr. Chairman, that the Air Quality Act of 1967 is a clear congressional directive to the Secretary of the Department of Health, Education, and Welfare to see that the provisions of the act are carried out. Since to carry them out requires the assistance of other departments and agencies, the Center uses the Office of Science and Technology as well as our collaborative research enterprises between agencies and departments.

The Provision of a Presidential Air Quality Advisory Board is the instrument that the Secretary will use as the essential element in seeing to it that the proper coordination and public policy posture is assumed. Over the years we have transferred funds to other agencies where expertise in areas reside. Through the knowledge of the programs, we have been able to espouse some particular points, and encourage others.

In regard to the Bureau of Mines—you were thoughtful enough to include Dr. Hibbard this morning—you will note that we have a very considerable effort involved in the fuel resources and how they can be best used for air pollution prevention. It is through our knowledge of areas of concern that they have offered their services, through the transfer of funds, through the directives of the present act and law, and by the Presidential memorandum to Secretaries and heads of agencies of April 21 last year, stating that the President continues to look to Secretary Gardner as the lead person in this area, that we have evolved at a very high level a capability of communication with concerned departments for effective action for air pollution control.

I think Dr. Ludwig's exposition to you about the air pollution predictions system and the fact that there is a Department of Commerce effort with ESSA people assigned and stationed in our National Center for Air Pollution Control, shows there is a very fertile field for the use of Federal people and resources cohesively to bring about a truly effective program.

We have similar relationships with the Department of Agriculture, as a further example of improved use of the Federal Establishment.

These are examples of how we have gone about collaboration and how we shall continue to do this. It is rather clear that the central responsibility is ours, and through the recognition of the large dimensions of the task we are trying to involve as many other agencies as we can, as well as the private sector, much more extensively than in the past.

Mr. DADDARIO. You are not suggesting that the Secretary of Health, Education, and Welfare can tell another Secretary or another agency head that he ought not to be spending some money in a field particularly related to, let us say, research in the air pollution area? What you say appears to me to mean that you can get help from these places and you can coordinate this activity and the information, but you cannot necessarily impose upon another agency a requirement to do something extra. You cannot say to them: "You are spending more money in this field than you ought to because other things appear to the Secretary of Health, Education, and Welfare to have a higher priority." This is the age-old problem which affects research in a multitude of areas. This matter of bringing cohesiveness to it, Dr. Middleton, is not so simple.

Dr. MIDDLETON. I quite recognize that, Mr. Chairman, and I say we are bringing about cohesiveness with a degree of modesty. Having been a professor at the University of California and having several campuses ——

Mr. DADDARIO. You mean cohesiveness and not chaos.

Dr. MIDDLETON. I mean cohesiveness and not chaos. I think the same kinds of independent elements we have in university systems exist in the Federal Government. This is to be espoused. I think where one finds excellence, one needs to identify it and capture it.

We capture this by knowing, for example, that many of the people in Dr. Hibbard's area are concerned with this problem of how we use our raw sources to advantage without causing air pollution.

Mr. DADDARIO. He may be concerned about it in a way differently than the Secretary of Health, Education, and Welfare because of the difference of their missions, and they may, in fact, both be justified, but one ought to have a priority above the other. Who makes that determination?

Dr. MIDDLETON. I think this is done by program planning and comparison of schedules to see what the priorities are. We can bring these kinds of things together through program planning, and then through the Office of Science and Technology, which has offered its coordinating role, as well as through the Bureau of the Budget, appropriate budget assignments can be effected.

Mr. DADDARIO. Dr. Middleton, we stand at a stage of the game where the future of pollution control really is ahead of us. We are developing a base upon which we can make a formidable mark. Would this not be the time to take a serious look at all of the work that is being done and come to some judgment about how to bring it together in a more meaningful way, rather than to try to do it through this cohesive informality that you are talking about?

Dr. MIDDLETON. I do not think the cohesive informality, Mr. Chairman, if I may suggest this, is as loose as perhaps you suggest. If we wish——

Mr. DADDARIO. I would think it would be looser.

Dr. Middleton. The informality of transferring funds to another agency on a contractual arrangement for the production of goods is rather a firm way to expect material results. This is not just interest in the problem. It is expecting the departments and agencies to produce answers to problems. We do this by quarterly reports, by terminal accounts, by having task forces of people who share in making decisions on what should be done. There is a whole variety of things that have been arranged prior to my coming, and there are many more since I have come, that lead to bringing the principals involved together at the working level for a much better understanding of what the issues are so that they can be properly investigated.

Mr. Daddario. Dr. Middleton, I do not suggest that you could sit here today and come up with the solution to this problem. However, it does appear to me we have an opportunity to do much more in drawing together this whole situation and putting it into order so that determinations can be made which can more effectively, efficiently, and expeditiously bring about our objectives in this area.

I feel, although the dangers which fall upon us may not be imminent, the time ahead may be the only opportunity we have to effectively control the great damage which might come to us 50, 100, or 200 years from now. Certainly, this committee will look very carefully into the structure of the activity which is taking place today, to see if, in fact, it can be improved. I do think that you also should be looking at that in that way.

It is not enough just to bring together people and develop another committee so these people can meet and talk about what they are doing. It seems to me there needs to be more of an overhauling here than the use of joint committee activity. This is fine in some cases, but it ought to be, I think, more finely formed.

Dr. Middleton. Mr. Chairman, I quite agree with this concept. It is toward that end that the Congress itself determined that there should be a Presidential Advisory Board for Air Quality. I think this should be a good sign that there is broad concern. I think the fact that our national advisory committees come from many places across the country, representing the private sector as well as the public sector, connotes something else.

More importantly, we are not dealing with this as a new issue. We have program plans and schedules that contemplate the reality and the dimension of the problem. This is not a new issue. It is an old issue.

Mr. Daddario. It is not a new issue, but it is an issue which we are beginning to look at as it ought to be looked at. The great expenditures in this area are in the future. It is not a new issue, but one which has developed a force of public opinion which demands that we do something in a very serious way. Because, as our past hearings indicate, this will be extremely costly, we ought to put together a mechanism which can see to it that these funds are expended in as efficient a way as possible and that we do tie together the local and State government activities, regions, or what have you, so that we will have effective administration and management.

Dr. **Middleton**. May I suggest that beyond the relationships within the Government we have the developing relationships with the private sector, and we expect to deeply involve them, not only in developing research and development for control technology purposes, but also for providing the facts as they relate to the production of criteria. In this regard you might be interested in the fact that in fiscal year 1966, about 30 percent of our budget was used in non-Federal research categories.

In 1967 we increased this from 30 percent to about 70 percent. We are marshaling the resources of private industry, all segments of industry, nonprofit institutions, a variety of technical resources, to bring new talent to bear, new ideas, newly involved people, so through the mechanism of the leadership of the Department of Health, Education, and Welfare I think we are not only succeeding in bringing about some Federal relationship improvement but, more significantly perhaps, we have been able to involve more significant external forces to have a concern with air pollution and its control.

Mr. **Daddario**. Mr. Brown?

Mr. **Brown**. I do not want to take a great deal of time on this but there are a couple of aspects of the research program that I would like to have you comment on very briefly.

One aspect of the total problem of controlling our environment and its pollution is that action in one field tends to sometimes have an effect in another field; for example, the control of air pollution may have an effect on water pollution or ground pollution.

I would like to know, in your program do you have adequate mechanisms for recognizing and dealing with this problem so that the total environment is maintained at some type of optimum level, and in the effort to provide clean air we do not at the same time produce adverse effects in other aspects of our environment?

Are you coordinating with those people trying to clean up the water and ground at the same time?

Dr. **Middleton**. May I ask Dr. Ludwig to respond?

Dr. **Ludwig**. Mr. Brown, we are quite aware of the interactions between the cleanup of air pollutants with the cleanup of water pollutants or the problems that are involved in solid waste disposal.

In the development of our program we don't look to the transferring of our problems to one of these other forms of disposal as an adequate solution. For instance, there is a great interface with the solid waste people who are interested in the disposal of these wastes by whatever means possible. One of these is incineration.

Of course, we have an interest in controlling pollution from incineration that extends from the development of add-on devices right back through improving the process so that it is nonpolluting to begin with. This requires that we do coordinate our programs with the solid waste programs in this regard.

We have a similar interface with the water pollution program, for instance, the development of one specific area for sulfur control involves the injection of dolomitic materials into the furnace. We are carrying this through to the point of what do you do with the slurry that you get finally which consists of gypsum and limestone and fly ash; how do you dispose of this?

You don't throw it down the sewer. This is integrated into the process as a piece of the control technology that is accountable to air rather than tossing it over for somebody else to take care of.

Mr. **Brown**. Organizationally, the responsibility in these areas of water and solid waste disposal are in other jurisdictions, is that true?

Dr. **Ludwig**. That is right. The solid waste is in HEW but the water pollution is in the Federal Water Pollution Control Administration.

Mr. **Brown**. One other question on the research aspect.

I see from your chart there in that central box you have research on controlled technology for motor vehicles, fuel combustion and industrial processes.

How broad do you envision the scope of the research effort that you are authorized to support? For example, does this include support of development of completely new technologies in transportation such as the electric-powered vehicle? Would it include the very broad research in terms of basic recycling processes which would have a major effect on the whole design of a city or something of that sort?

Have you developed limits on your mandate? Are you searching for these limits at the present time?

Dr. **Ludwig**. No. I would say that in looking at the problem, we categorize these in first, second, and third generation types of activity.

For instance, as an example, in the control of sulfur from powerplants, we have a group of prospective control methods that we put in the first generation category, which consists of getting into and through the full demonstration stage as soon as possible those techniques that appear most promising at the present time.

At the same time that we are doing this we are developing on the bench scale new categories of control possibilities which we would hope to be able to put into the pilot plant in full demonstration scale in 4 or 5 years from now.

While we are doing this, in the third generation type of activity, we are taking a look at new power system concepts, whole new ways of producing power where you integrate air pollution control into the power system itself. An example of this would be to develop gasification that was particularly adaptable to a certain form of power generation.

We are considering the full gamut of activities here which look down the road of how to reach the goal that is going to be necessary 20, 30 years from now.

Mr. **Brown**. This again brings up some very interesting problems because in the total picture of stationary power production facilities we are moving rapidly toward nuclear power. Nuclear power is not going to pollute the air but an awful lot of water in trying to dispose of these wastes in the ocean, or it may have some other effects which are no concern of yours. They should be of concern to those who worry about the total environment.

This may be even beyond the nuclear power stage developments in other powers which would provide some other similar type of problems. It bothers me a little in terms of the responsibility of Congress for the total development in all of these areas, that there might not be adequate central coordination and planning for the kinds of problems that develop here.

You might not worry about the nuclear power wastes because they do not involve air pollution, but somebody has to worry about them. They should be closely coordinated worriers, actually.

Dr. **Middleton**. Mr. Chairman, I concur in the concern.

May I give you a specific example for Mr. Brown of how we begin to meet this in a rather modest way.

We have a member of the National Center for Air Pollution Control assigned to work with the Bonneville Power Authority. This group is concerned not only with hydroelectric and atomic energy systems, but also with burning of fossil fuels for power production. Our representative is a specialist in effluents from combustion of fuels as well as radioactive wastes, and works on an ongoing daily basis with the people who are concerned with all of the new forms of power generation.

Consideration is given at that working level to plans suggested for all sources for deriving power. Through this liaison the Center has established effective air pollution abatement protocols and ongoing, regular, professional contact with all the Federal agencies concerned, as well as public agencies associated with power development.

This may be too low level to meet your needs, but it does cite another example, may I suggest, of ways that informal associations often meet to provide practical solutions.

Mr. **Brown**. It seems to me, getting back to the type of problem the chairman raised earlier about organization, we may be in the future needing to move in the direction of an organizational framework which is concerned broadly with the problems of a satisfactory environment for the human being, physical environment—I am not talking about the psychological or political environment—physical environment.

Perhaps some framework similar to the present ESSA would deal broadly with all of these problems and coordinate them. It seems that placing your operations under HEW is a recognition of its effect upon the health, I presume, of the ordinary human being.

As you pointed out, there are far larger consequences, for example, on agriculture. Why don't we put it in the Department of Agriculture?

There are economic effects on the automobile industry. Why don't we put it in the Department of Transportation?

It is a basic thing which we are trying to develop with the environment. HEW deals with human beings as human beings, and a logical arrangement might ultimately be to group all of these concerns with the environment into one kind of a structure to deal with them on that basis.

Do you visualize this as occurring or being reasonable? Is it something that might develop over the course of the next few years?

Dr. **Middleton**. In response, I should say that HEW has a prime role in this not solely because of its effect on the health of persons, but also its effect on welfare.

The real answer to your question is that there needs to be a concern for the total environment. To do this prudently, we need to exercise best use of the several components that need to be involved.

It is obvious to me that this is a matter of real concern to the executive branch; the President has often stated his concern. His concern for this and his measures for bringing about some resolution of the problem will hasten restoration of the quality of our environment.

We have, as a matter of fact, with the Commerce Technical Advisory Board Report on Electric Powered Vehicles, involved Commerce. The Department of Transportation, as well as HUD are involved with HEW.

As an example, the Bureau of the Budget is bringing together the several elements in a few days to discuss this particular problem of motor vehicle pollution as it affects the total environment. It seems to me these are the mechanisms that are extant that can be exercised by the executive branch.

Mr. **Brown.** I recognize that the devices that you described are being used to secure the type of focus that we need and no system is going to be perfect. Obviously we don't expect that, but we do expect something that is logical.

In connection with your work in California, did the Motor Vehicle Pollution Control Board report to the Department of Health in California or some other organization?

Dr. **Middleton.** It reported directly to the Office of the Governor. It was responsive to the Governor's Office.

Mr. **Brown.** I have no further questions.

Mr. **Daddario.** Dr. Middleton, could we then proceed with Dr. Blomquist?

Mr. **Ryan.** Mr. Chairman.

Mr. **Daddario.** I am sorry, I did not know that you wanted to be called on, Mr. Ryan.

Mr. **Ryan.** I realize the time is late but, Dr. Middleton, as you know, during congressional consideration of the Clean Air Act of 1967, I argued for a different approach from the one adopted by the Congress. I felt that the approach adopted by the Congress was too State oriented and would result in a number of built-in delays. What I would like to ask, referring to page 6 of your testimony, you state that the Department will designate air quality control regions. I think the Department also is required under the act to designate atmospheric areas and define them.

Could you tell us what the timetable is for this? Before we can get State action and before the States submit plans and statutes, there are certain steps that the Department of Health, Education, and Welfare has to take. Can you give us specifically what you see as your timetable?

You already designated atmospheric regions.

Dr. **Middleton.** Mr. Chairman, Mr. Ryan, in response to the Congress' wishes, we have placed special emphasis on key items. One of these is the description of atmospheric areas. The atmospheric areas of the United States have already been described and published in the Federal Register, I believe January 10.

Mr. **Ryan.** What is the next step?

Dr. **Middleton.** The next step is to designate air quality control regions in which the Department of Health, Education, and Welfare will have areas of particular concern on the health and welfare. May I refer especially to the fact that this may or may not involve a compact between the States, agreements between the States or among themselves, but call attention to the fact when one deals with compacts with States, that under section 102(c) there is a particular item of interest perhaps to you.

If I may read it. This is a partial reading of that section:

> It is the intent of Congress that no agreement or compact entered into between states after the date of enactment of the Air Quality Act of 1967, which relates to the control and abatement of air pollution in an air quality control region shall provide for participation by a state which is not included in whole or in part in such air quality control regions.

We are attempting to enunciate that the designation of air quality control regions shall identify a community of interest in a common air pollution problem. This, then, suggests some of the principles involved in the designation of air quality control regions. They will be descriptive of and include the communities and political jurisdictions that have the problem and are able to cope with it. This means that there will be many, many such air quality control regions scattered across the country in those critical problem areas. The exact number I cannot forecast, but we are talking of more than 100. I am hopeful that we will be able to designate several of the more important ones before the close of this fiscal year. This is a task, Mr. Chairman, that requires considerable scientific enterprise and a great deal of technology.

Mr. DADDARIO. Does it require just enterprise or does it require research so that such a scientific and technical capability can be developed and so that airsheds or air regions, however you may put it, can in fact be established firmly?

Dr. MIDDLETON. I advisedly use the word "enterprise." Much of the information that is required, most in fact exists. It takes ingenuity and effort to see that what exists can be brought into the format that is required; namely, for this particular purpose, mathematical modeling of cities, diffusion gradients for pollutants, the nature of the urban community, probable growth factors. All of these elements when put together are the essence of the principles involved in the description of air quality control regions.

I am saying that to do this initially will be an arduous task and an exacting one, but it can be done and it can be done shortly. After the first few have been well worked out, it is my opinion that the several more that are required will emerge much more quickly.

I will be nonspecifically responsive, if I may, on how many at what particular time, except to say we expect to have several before the end of this fiscal year and many, many more in the next fiscal year.

Mr. RYAN. As you designate those air quality control regions, will you simultaneously or at a later point issue the air quality criteria for those regions? I am trying to understand the timetable.

As I understand it, after you issue the criteria, the States still have 15 months in which to submit a plan to you.

Without prolonging this discussion this morning because the time is short, how soon can we expect the first State to come forward with a plan under the statute?

Dr. MIDDLETON. Under the statute, if we publish today an air quality criterion for some pollutant, within 90 days we would expect—and by "published" I mean properly announced—we would expect in 90 days the State to indicate its intent to adopt an ambient air quality standard. The State then would have, as you are enunciating very clearly, 6 months in which to adopt this standard. It would then have an additional 6 months in which to provide, for the Secretary's consideration, an implementation plan.

This, then, means that a year and 3 months would elapse prior to any abatement activity on the part of State or local government. The applicability of those adopted standards, so far as the Federal Government is concerned, is in the air quality control regions. We need not to do things just in sequence but in parallel, which is a terrific task. We need not only now to designate the air quality control regions but simultaneously publish criteria so that we can bring about a State action. Toward this end, Dr. Blomquist and his staff are working assiduously to produce the appropriate technical documents with the appropriate consultation with the Federal agencies as well as the private sectors and the academic world to see that the criteria we enunciate in fact display the scientific facts in an exercise of superior judgment and lucid written description.

Once this is done, with the control techniques available and the costs thereof, the triggering mechanism is set in motion. Toward this end, we are asking that there be appointed a National Advisory Committee on Air Quality Criteria. We are proposing a prescribed membership. We have in the meanwhile staff activities directed toward development of specific pollutant criteria. A list of these were given, Mr. Chairman, to the Senate Public Works Committee. This listing is being changed in sequence because of the added need now to have control technology and their costs. Publishing them in the time frame we had originally described will be changed to meet the control technology and costs that we presently have available.

We would expect to have by the close of this fiscal year, certainly, criteria on particulate matter, a consideration of the reevaluation of sulphur oxides, and perhaps carbon monoxide. These are the principal pollutants in many places and they are the ones which would initiate the actions that you have mentioned.

Mr. RYAN. I am concerned about the fact that the act requires you to recall your criteria on sulphur oxides.

I think that was a mistake. It was written into the law. How soon can you reissue it? I will correct that. That is the way you read the law, isn't it?

Dr. MIDDLETON. Yes.

They will be reevaluated and, toward this end, we have the mechanisms in motion for their reevaluation. When they will be published bears on some other issues over which I have little control. There will be no effort wanting to have them ready for publication shortly.

Mr. RYAN. Let me urge you to move with dispatch on this.

Mr. Chairman, might we have that listing which Dr. Middleton mentioned for our record?

Mr. DADDARIO. Yes.

(The information requested is as follows:)

The listing of planned publication dates of air quality criteria cited by Dr. Middleton appeared on pages 2334–2335 of Part 4 of the record of hearings on the Air Quality Act before the Subcommittee on Air and Water Pollution of the Senate Committee on Public Works. That listing is now nearly a year old.

Air quality criteria are now being prepared in accordance with the following schedule: Publication in Fiscal 1968: particulate matter and (following reevaluation of the criteria originally published in March 1967) sulfur oxides; publication in Fiscal 1969: oxidants, carbon monoxide, hydrocarbons, and nitrogen oxides; planned for later publication: beryllium, fluorides, hydrogen sulfide, lead, odors, and polynuclear hydrocarbons.

Mr. Ryan. Also, a copy of the atmospheric air regions that you have already designated?

Dr. Middleton. Pleased to supply them.

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE—OFFICE OF THE SECRETARY

AIR POLLUTION PREVENTION AND CONTROL—DEFINITION OF ATMOSPHEREIC AREAS

Notice is hereby given that, pursuant to section 107(a) (1) of the Clean Air Act, as amended by the Air Quality Act of 1967 (Public Law 90–148), the Atmospheric areas of the Nation are defined as set out below on the basis of those conditions which affect the interchange and diffusion of pollutants in the atmosphere.

Important meteorological parameters that affect the interchange and diffusion of airborne pollutants are the frequently, persistence, and height variation of stable (inversion) layers of air and speed and direction of wind. Accordingly, the boundaries of the Atmospheric areas are based on annual averages of (a) low-level inversion frequency, (b) maximum depths of vertical mixing, and (c) the frequency of light winds.

Collectively, an assessment of these parameters provides a measure of the dilution climatology of an area, that is, a history of the experience of air movements as it relates to the dilution of pollutants. This conceput of dilution climatology is embodied in the High Air Pollution Potential (HAPP) Advisory System, initiated by the National Center for Air Pollution Control (NCAPC) in the eastern United States in 1960 and the western United States in 1963, and now administered by the Environmental Science Services Administration (ESSA). The HAPP Advisory System provides a forecase of weather conditions conducive to the accumulation of air pollutants over large areas, a factor which was considered in the definition of these Atmospheric areas.

Because of the direct relationship of the area boundaries to the average meteorological conditions of large-scale areas, these bounaries do not necessarily reflect the actual meteorology in the immediate vicinity of the boundaries. In other words, there will always be special "boundary conditions" characterized by the movement of air, together with airborne pollutants, across the boundary. The boundaries are shown as zones on the map in order to reflect this boundary condition.

Furthermore, since the boundary between any two areas is defined by average annual conditions it is transitory on the basis of shorter period (e.g., seasonal or diurnal) variations in meterological conditons, with the result that Pittsburgh, for example, is under the influence of the average dilution climatology of the Appalachian Atmospheric area during certain times of the year and under the influence of the Great Lakes-Northeast Atmospheric areat at other times during the year. Similarly, Portland, Oreg., New York City, or any other place in the near vicinity of an Atmospheric area boundary could be under the influence of a neighboring Atmospheric area during certain periods.

Major topographical features are also reflected in the delineation of Atmospheric areas. The eastern boundary of the two Atmospheric areas on the West Coast lies for the most part at the 2,000- to 3,000-foot elevation contour interval on the western sdope of the first major mountain chain, and it marks in general the inland extent of the major influence of maritime air. The boundary between the Rocky Mountain Area and the Great Plains Area is essentially located at the 3,000- to 4,000-foot elevation contour interval. The effects of the Great Lakes and the Appalachian Mountains are apparent in the location of boundaries between Atmospheric areas in the eastern United States.

A brief description of each Atmospheric area is given in the attached table. including the geographical extent of each area and the major characteristics of the dilution climate. Definition of Atmospheric areas outside of the continguous United States has been deferred.

The existence of Atmospheric areas, as defined herein, does not in any way limit the designation of Air Quality Control regions pursuant to section 107(a) (2) of the Clean Air Act, as amended.

Dated: January 9, 1968.

[SEAL]

JOHN W. GARDNER, *Secretary.*

DESCRIPTION OF ATMOSPHERIC AREAS AND THEIR CHARACTERISTICS, AIR QUALITY ACT OF 1967

Atmospheric area	Extent of area	Meteorological and topographical characteristics
California-Oregon coastal area	Extends about 20 to 50 miles inland from the Pacific Ocean.	Maritime air penetration; prevailing shallow vertical mixing depths; topographic restraints on ventilation in coastal valleys and basins.
Washington coastal area	Extends about 20 to 30 miles inland from the Puget Sound region, from which the eastern boundary extends southwestward to the vicinity of Longview on the Columbia River and then westward to the coast.	Precipitation, cloudiness, and relatively high winds are dominant features of the climate, which distinguishes this area from the adjacent areas. Storm activity is frequent, particularly during winter and spring seasons; the frequent storm passages result in a low occurrence of persistent stagnation.
Rocky Mountain area	Extends eastward from the California-Oregon and Washington coastal areas, to terminate as a north-south oriented eastern boundary, essentially corresponding to the 3,000- to 4,000-foot mean sea level contour interval which in general defines the easternmost extension of the major mountain ranges. This eastern boundary stretches from the Canadian border in Montana southward through extreme eastern Colorado, eastern New Mexico, to the Mexican border, to include the Big Bend region of Texas.	Topographic restriction, channeling of winds, particularly frequent surface-based inversions at night, and relatively deep mixing depths during the afternoon are prevalent features of the dilution climate of the area.
Great Plains area	Extends eastward from the Rocky Mountain area to the Mississippi River south of Missouri; to the north it includes most of Illinois, southwestern Indiana, southwestern Wisconsin, and all but extreme northeast Minnesota.	Relatively flat terrain, which stretches from the Canadian border to the Gulf of Mexico, characterizes the topography. The dilution climate is characterized by negligible persistent atmospheric stagnation and the frequent occurrence of relatively high winds with rapidly changing meteorological conditions.
Great Lakes-Northeast area	In addition to regions adjacent to the Great Lakes this area includes the northern ⅔ of the States of Indiana and Ohio, the Allegheny Plateau area of northwestern Pennsylvania, all of New York State but the extreme southern part of the Hudson River Valley, and the New England States north of the Connecticut-Rhode Island coastal area.	The meteorology is characterized by frequent storm passages with attendant high winds and generally good dilution conditions. During the spring and early summer months, winds blowing from over the cold waters of the Great Lakes and Atlantic Ocean enhance low-level stability in regions adjacent to these bodies of water.
Appalachian area	The eastern boundary of this area, which extends from northern New Jersey southward through southeastern Pennsylvania, eastern Virginia to the Atlantic coastline at the South Carolina border, is correlative for the most part with the 300- to 500-feet mean sea level contour interval. This contour interval at the foothills of the Blue Ridge Mountain Range distinguishes the relatively flat coastal plain to the east from the Appalachian Mountains. The area extends southward to the Gulf of Mexico, including northern Florida, and is bounded in the west and north by 2 other atmospheric areas.	Dominant features of the dilution cilmate include light wind speeds and the most frequent stagnation conditions of any region east of the Rocky Mountains.
Mid-Atlantic coastal area	Encompasses the Atlantic coastal plain from extreme southwestern Connecticut, including the New York City and Long Island region, southward to the South Carolina border at the coastline, and extends inland to the Appalachian area.	Shallow mixing depths, less frequent low-level stability and higher wind speeds are features of the dilution climate that distinguishes this coastal area from those adjacent.
South Florida area	Extends south from the Daytona Beach-Cedar Key line to include the southern half of Florida.	The climate of this area is predominantly tropical-marine in nature. Atmospheric stagnation is practically nonexistent; there is a small frequency of low-level stability; and relatively good vertical mixing prevails.

Source: Federal Register, vol. 33, no. 10, Tuesday, Jan. 16, 1968.

Mr. DADDARIO. What don't you have control over? What prevents you?

Dr. MIDDLETON. The exercise of the esteemed judgments of our consultants, the fact that I would like to have enough time for free consultation so that the people we ask to participate in our National Advisory Committee are free agents, that they in fact come together because we ask them to come because they have something to offer.

This means that they have to become involved. Bringing this about is not just something that one legislates; this is done by a variety of techniques, some of which this committee is well accustomed.

Mr. DADDARIO. This gets you back to that formula you have established for yourself in bringing together the best possible people in order to accomplish your objectives.

Dr. MIDDLETON. Yes, sir.

Mr. DADDARIO. This is the status at the moment?

Dr. MIDDLETON. Just the normal clearance system in government seems to be an arduous task. My restlessness is something that I will apparently have to be content with.

Mr. DADDARIO. Mr. Bell?

Mr. BELL. Dr. Middleton, as I understand—and I hate to belabor this question. But relative to State and National rights as far as State rights are concerned, as I understand it, a State can take a more stringent action on air pollution.

You say on page 8, "The act prescribes procedures to be followed in the event a State either fails to meet its obligations or submits standards which are not consistent with the provisions of the act."

Again we go back to that situation, if a State were to take some actions that were not consistent with the provisions of the act, acting perhaps in advance of what your office would want them to do, what would be the situation? Would you be able to say no if Los Angeles or California decided to move on something that was not exactly consistent with the provisions of the act? You would be able to prevent them from acting, is that correct?

Dr. MIDDLETON. Again, Mr. Bell, I need to reiterate our desire to see States such as California step forward and offer some leadership. It is not the intent of the Federal Government to forestall control of air pollution at the State and local level. Consistent with the act in this sense can be construed to mean that when the criteria are published and the State says they intend to adopt a standard, the standard they then promulgate, or propose, when sent to the Secretary, is found to be consistent with the published criteria. If the standard is half as potent as it should be, based on criteria, it is nonconsistent and poorer.

Mr. BELL. The State standard is better?

Dr. MIDDLETON. The State standard in that case is a larger number, which means less good. Not half, meaning twice as good. Are we confused or together at this point?

Mr. BELL. I think we are together.

Dr. MIDDLETON. I mean if the State comes up with a standard that is poor and inconsistent with the criteria, then there is a course of action to bring the views together and make a finding. The finding is binding.

Mr. BELL. In other words, what you really are saying is if they reach an impasse where there is a difference of opinion, it would be the same thing. Try to bring the views together. You are not going to say the Federal Government must bring your standards into a system with our provisions?

Dr. MIDDLETON. We are saying the standard advocated, recommended by the State and reviewed by the Secretary, must be consistent with the information given to the State enabling them to allow a standard to be established. What is "consistent," I have only used as an illustration here. They, the States, may be less concerned with the particular pollutant and decide they are not going to have an "adequate" standard; that is, it will not protect the health of people.

In this case the Secretary perhaps would indicate the inadequacies of the State standard and perhaps by consultation, indicate to the State the need for its improvement.

In the event this is unacceptable to the State, a legal course of action and establishment of a hearing board, making a finding, resolves the issue.

Mr. **Bell**. On page 10 you made a statement relative to the 1968 model cars and trucks. You said that 2 weeks ago you proposed more stringent standards for such vehicles for initial application of the 1970 model years. I do not believe in the rest of the statement that you indicated what those were.

Dr. **Middleton**. No, I did not. I can introduce this material for the record.

Mr. **Bell**. If you would.

Dr. **Middleton**. The Federal Register provides very extensive documentation of what these standards are.

Mr. **Daddario**. Please do so.

(The standards referred to may be found in the Federal Register, vol. 33, No. 2, pp. 110–130, dated Jan. 4, 1968, and entitled "Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines—Proposed 1970 Standards.")

Mr. **Bell**. Thank you, Dr. Middleton. I appreciate your very fine statement and your answers to the questions. I remember hearing considerable praise about your efforts in Los Angeles and the good job you have done.

Dr. **Middleton**. You are very generous. Thank you.

(Dr. Middleton's complete prepared statement follows:)

PREPARED STATEMENT BY DR. JOHN T. MIDDLETON, DIRECTOR, NATIONAL CENTER FOR AIR POLLUTION CONTROL, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. Chairman and members of the Subcommittee, I am pleased to have this opportunity to discuss with you the activities of the Department of Health, Education, and Welfare in the area of air pollution research and control. In the period since your 1966 hearings on environmental pollution, important new dimensions have been added to the Department's air pollution program. I am referring, of course, to the enactment of the Air Quality Act of 1967, which became law last November 21st and which is destined to have a profound influence on all the air pollution research and control activities of government and industry for many years to come.

The enactment of the Air Quality Act marked the start of a new era in the Nation's attack on the growing problem of air pollution—an era in which the knowledge we already have about this problem and its prevention and control will be systematically and scientifically applied in all parts of the country, while at the same time, a greatly increased effort will be made to develop the additional knowledge we must have if we are to prevent the air pollution problem from continuing to grow and worsen.

The Air Quality Act offers no short cuts to effective control of air pollution. There is no short cut to the solution of such a complicated problem. Air pollution is a by-product of all the major growth factors of modern society; it is rooted in the way we build our cities, the ways in which we provide transportation for ourselves and our goods, the ways in which we derive energy from our fuel resources, the ways in which we produce and use a multitude of goods and services, and the ways in which we dispose of all the leftovers of modern life. The effects of air pollution are diverse and often subtle. Polluted air contributes to human sickness, disability, and premature death; it soils and damages buildings and materials of all kinds; it injures and destroys farm crops and other vegetation; and it blights our cities and degrades the quality of our lives.

A problem such as air pollution, which has such far-reaching economic, social, and technological ramifications, must obviously be attacked along a broad front. The solution does not lie only in the enforcement of laws and regulations or only in the application of engineering techniques or economic formulas. Achieving effective control of air pollution will require a combination of these approaches and many others. Moreover, it will require the combined efforts of all levels of government and all segments of industry.

In the four years since the enactment of the Clean Air Act of 1963, the Nation has made progress in the fight against air pollution. Federal grants have helped to produce an unprecedented expansion of State and local governmental control programs. Federal abatement action has paved the way for State and local agencies to join the Federal Government in attacking interstate air pollution problems in several places, including the National Capital area. National standards have been adopted for the control of air pollution from new motor vehicles, thus extending to the entire Nation the initial benefits of technological progress in dealing with one of the most important aspects of the total problem of air pollution. Finally, the increasing emphasis placed on control action during the past four years has served not only to bring a few more sources of air pollution under control, but also, and more significantly, it has helped to stimulate a greatly intensified effort to develop new and improved control technology—an effort which has already begun to bear fruit, particularly with respect to motor vehicle pollution and sulfur pollution arising from fuel combustion.

But there are still many gaps remaining to be filled. Our scientific and technical knowledge in many areas is still incomplete. We need more complete information on the importance of the many pollutants whose adverse effects are not as readily apparent as are the effects of such common contaminants as the sulfur oxides, photochemical smog, and visible particulate matter. Economic data on the impact of air pollution and the costs of controlling it are still not as precise as we would like them to be. Needs for manpower must be better defined and plans made for meeting them. Above all, since air pollution is inherently a regional problem, we must make certain that we attack it on a regional basis.

The Air Quality Act of 1967 was developed in full awareness of how comprehensive an effort it will take to achieve truly effective control of air pollution in this country. This new legislation is a blueprint, which, if properly employed, will allow us to correct all the important deficiencies in our current control efforts—the gaps in our scientific and technical knowledge, as well as the inadequacies in our application of existing knowledge. The Air Quality Act sets up a research-and-control system which will be coordinated at the Federal level but will involve a high degree of participation by other levels of government and by all segments of industry. I will take just a few minutes to explain, without going into great detail, how the Air Quality Act will affect air pollution research and development activities in the months and years ahead and, more importantly, how these activities and control activities are interrelated and interdependent.

Air pollution, as I have already said, is inherently a regional problem, simply because the air, whether polluted or not, flows freely across the boundary lines that divide States and cities. This means, of course, that in most, perhaps all, places where air pollution is a problem, effective control action will require the coordinated efforts of numerous local governments and, in many instances, of two or more States. This is fully recognized in the Air Quality Act. One of the chief purposes of the Act is to insure that State governments, in cooperation with municipal and county governments, will develop and apply air quality standards on a regional basis in all parts of the country. Toward this end, the Department of Health, Education, and Welfare will designate air quality control regions, each of which will consist of a group of communities that share a common air pollution problem. Air quality control regions will be designated on the basis of such factors as meteorology and topography, jurisdictional boundaries, and the extent of urban-industrial concentrations.

States will not actually be obligated to begin developing air quality standards for any pollutant until the Department of Health, Education, and Welfare publishes air quality criteria for that pollutant *and* information on available control techniques applicable to the various sources of that pollutant. Air quality criteria will describe the effects of air pollutants on health and property. They will reflect the best available scientific knowledge, even though that knowledge may not be as complete as we would like it to be. The information we will publish on control technology will identify the best techniques available for reducing pollutant emissions at their various sources, whether those techniques involve the application of control equipment, changes in fuel use or industrial processes, or any other practical approach. Since air quality criteria and information on control technology must be published *before* States can be called upon to begin developing air quality standards, the Air Quality Act must clearly be implemented as fully as possible on the basis of the best scientific and technical knowledge already available, while at the same time, an expanded research effort is undertaken to fill the gaps in this knowledge. Any other course would inevitably result in a slowdown of the Nation's efforts to deal with a problem that is already serious and threatens to reach critical proportions all too soon.

The publication of air quality criteria for a pollutant and information on applicable control technology will be the signal for States to begin developing air quality standards for that pollutant and detailed plans for implementation of the standards in air quality control regions that have been designated by the Department of Health, Education, and Welfare. Air quality standards will prescribe limitations on ambient air levels of pollutants in a region; since the fundamental purpose of setting such standards is to provide for the protection of public health and welfare, State governments will be expected to consider, among other things, the air quality criteria that have been published in accordance with the Air Quality Act. States will also be expected to take into consideration the published information on control technology.

The Air Quality Act sets up a timetable which States must follow in developing air quality standards and implementation plans and requires that the standards and plans be reviewed by the Department of Health, Education, and Welfare. In addition, the Act prescribes the procedures to be followed in the event that a State either fails to meet its obligations or submits standards which are not consistent with the provisions of the Act. And finally, the Act makes it clear that States will be expected to assume the major responsibility for seeing that their plans for implementation of air quality standards are carried out. If action by a State proves inadequate, however, provision is made for enforcement at the Federal level.

I indicated, a few moments ago, the importance of research to expand and improve our knowledge of the adverse effects of air pollution and of ways to prevent and control it. The Air Quality Act provides for a substantially accelerated research effort, with special emphasis on finding new and improved ways of dealing with the complex and very serious problems associated with motor vehicles and the use of sulfur-containing fuels. We will, of course, expand the work being done in our own facilities and in those of other Federal departments and agencies. But we will have to rely, too, on the many industries that are capable of contributing to the search for practical solutions to the various technical problems involved in controlling air pollution; indeed, we have already begun moving toward much greater utilization of the resources of industry.

The Air Quality Act also provides for continuation of many of the activities initiated under the Clean Air Act of 1963. One of these activities is the abatement of interstate and intrastate air pollution problems; this activity, as I have already noted, has been productive in several places in the country. In addition, the Air Quality Act provides new authority for court action to curtail pollutant emissions in emergency situations—that is, when adverse meteorological conditions threaten to produce an episode of extraordinarily high air pollution levels in any place in the country.

Another activity that will be continued is the awarding of matching grants to local, State, and regional governmental agencies to help them create and carry on effective programs for the prevention and control of air pollution.

These grants will also be available to assist such agencies in meeting the new responsibilities which will be placed upon them under the provisions of the Air Quality Act. In addition, funds may also be made available to support the work of planning commissions set up by States to assist in the development of air quality standards in interstate air quality control regions.

The establishment of national standards for the control of air pollution from new motor vehicles, first authorized by the 1965 amendments to the Clean Air Act, will also be continued. Such standards are now in effect for 1968-model cars and light trucks using gasoline as their fuel. Two weeks ago, we proposed more stringent standards for such vehicles for initial application in the 1970 model year. In addition, standards were proposed for the control of smoke emissions from diesel buses and trucks.

Our activities relating to the prevention and control of air pollution from Federal installations will also continue. There has been marked progress in this work, due in large part to the high degree of cooperation we have been getting from other Federal departments and agencies. For the first time, the Federal Government now has a detailed inventory of air pollution sources at all its installation and comprehensive plans for control action, wherever such action is necessary.

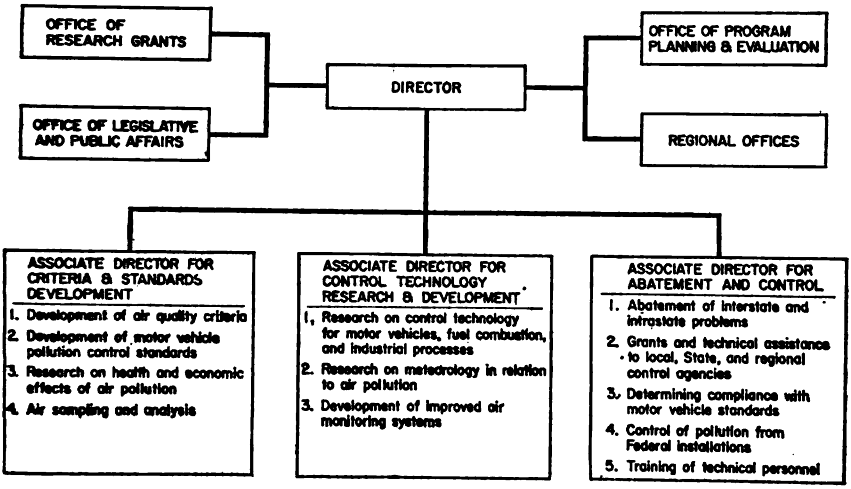
A number of new activities will be initiated under the Air Quality Act in support of the research-and-control system which the Act sets up. Among these will be a program for registration of fuel additives, whose use already contributes, and in the future may well contribute even more, to all environmental pollution problems; a study of the need for and effect of national emission standards for major industrial sources of air pollution, with a report to the Congress due two years from enactment of the Act; a comprehensive study of the economic costs of controlling air pollution, including costs that will be incurred by both government and industry; an investigation of manpower needs in the air pollution field and of needs for training programs; and finally, a study of ways to control air pollution from aircraft and of the feasibility of establishing national emission standards applicable to aircraft.

In implementing the provisions of the Air Quality Act, we will have opportunities to solicit the advice and assistance of all those segments of the Nation's population who are concerned with the problem of air pollution and who are in a position to help us. The Act provides for the creation of a Presidential Air Quality Advisory Board as well as technical advisory committees. The membership of these groups will include State and local officials, representatives of business and industry, scientists, and so on.

This completes my summary of the provisions of the Air Quality Act. This legislation, as I said at the beginning of my statement, opens a new era in the Nation's fight against the threat of air pollution. Exactly how fast our progress in this new era will be will depend heavily on how promptly and effectively all levels of government and all segments of industry pursue the roles they are expected to play. The Air Quality Act binds all levels of government and industry together and provides for us all a comprehensive plan for attacking air pollution; if any of us fails to do his job, the plan cannot completely fulfill the promise it holds. In signing the Act, President Johnson reminded us that "It is a law—not a magic wand to wave and cleanse our skies. It is a law whose ultimate effectiveness rests with the people."

A great deal of work must be done to translate the law into action. Air quality criteria must be developed. Air quality standards must be set and enforced. An accelerated research effort must be undertaken. All this and more must be accomplished if we are to stop the rising tide of air pollution and begin to turn it downward. I believe that under the provisions of the Air Quality Act, this can be done. I assure you that the National Center for Air Pollution Control will strive to carry out, as promptly and as thoroughly as possible, all of its responsibilities under the Act, so that States, local governments, and industry will have the tools they need to move the Nation toward better control of air pollution.

NATIONAL CENTER FOR AIR POLLUTION CONTROL



DIRECTOR

OFFICE OF RESEARCH GRANTS

OFFICE OF LEGISLATIVE AND PUBLIC AFFAIRS

OFFICE OF PROGRAM PLANNING & EVALUATION

REGIONAL OFFICES

ASSOCIATE DIRECTOR FOR CRITERIA & STANDARDS DEVELOPMENT

1. Development of air quality criteria
2. Development of motor vehicle pollution control standards
3. Research on health and economic effects of air pollution
4. Air sampling and analysis

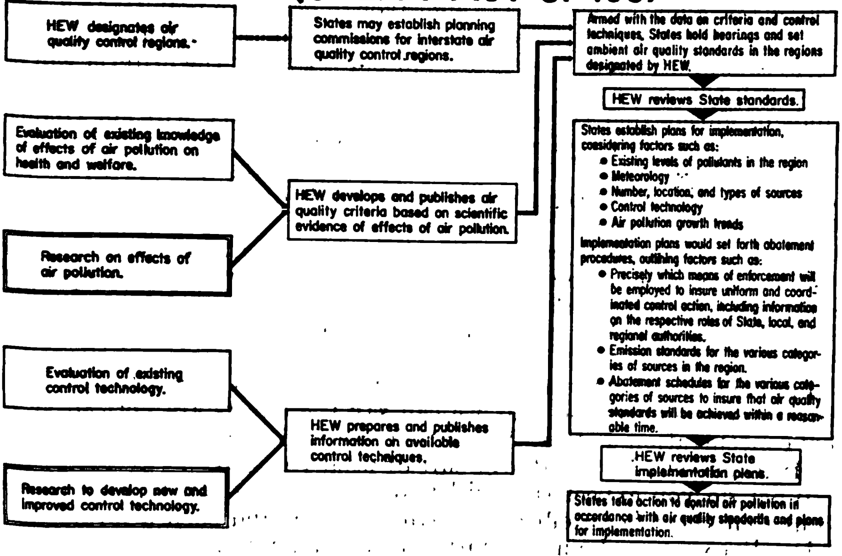
ASSOCIATE DIRECTOR FOR CONTROL TECHNOLOGY RESEARCH & DEVELOPMENT

1. Research on control technology for motor vehicles, fuel combustion, and industrial processes
2. Research on meteorology in relation to air pollution
3. Development of improved air monitoring systems

ASSOCIATE DIRECTOR FOR ABATEMENT AND CONTROL

1. Abatement of interstate and intrastate problems
2. Grants and technical assistance to local, State, and regional control agencies
3. Determining compliance with motor vehicle standards
4. Control of pollution from Federal installations
5. Training of technical personnel

AIR QUALITY ACT OF 1967



HEW designates air quality control regions.

States may establish planning commissions for interstate air quality control regions.

Evaluation of existing knowledge of effects of air pollution on health and welfare.

Research on effects of air pollution.

HEW develops and publishes air quality criteria based on scientific evidence of effects of air pollution.

Evaluation of existing control technology.

Research to develop new and improved control technology.

HEW prepares and publishes information on available control techniques.

Armed with the data on criteria and control techniques, States hold hearings and set ambient air quality standards in the regions designated by HEW.

HEW reviews State standards.

States establish plans for implementation, considering factors such as:

- Existing levels of pollutants in the region
- Meteorology
- Number, location, and types of sources
- Control technology
- Air pollution growth trends

Implementation plans would set forth abatement procedures, outlining factors such as:

- Precisely which means of enforcement will be employed to insure uniform and coordinated control action, including information on the respective roles of State, local, and regional authorities.
- Emission standards for the various categories of sources in the region.
- Abatement schedules for the various categories of sources to insure that air quality standards will be achieved within a reasonable time.

HEW reviews State implementation plans.

States take action to control air pollution in accordance with air quality standards and plans for implementation.

Mr. DADDARIO. If we might proceed just a bit longer. Could we have Dr. Blomquist run as quickly as possible through the criteria. It may give us an idea as to whether or not you could come back again.

Dr. MIDDLETON. Perhaps you would like to be responsive by asking questions or whatever fits within your time schedule.

Mr. DADDARIO. Why don't you just begin and see where we go from there. I think this whole criteria from the medical standpoint is vital.

Dr. BLOMQUIST. I should like to say we are working on a series of criteria documents, as has already been indicated. We have published the ones on oxides of sulfur and will shortly have that reevaluated, as Dr. Middleton said. On the drawing board we have other pollutions under consideration. They are carbon monoxide, the photochemical oxidants, particulates, the oxides of nitrogen, and hydrocarbons. Those are the ones on which we are working currently.

We have approached the problem as one trying to determine as best we can from the available literature and new research what are the effects associated with these various pollutants in terms of their concentration and time; that is, the dose.

As we look at the effects, we are primarily concerned with the health effects but we are likewise concerned with the effects of these pollutants on vegetation and visibility, and materials damage. The criteria will include the relationship of concentration with health and the kinds of effects as expressed in various parameters.

The documents that we have on the drawing boards are divided pretty well into four areas. There will be a discussion as well as documentation on these effects in these four areas. Then we try to answer from the experimental data the critical question; namely, how accurately can we predict at what level these effects begin?

I think the most important question that most people are asking is to how low a low do we have to endeavor to get these pollutants before effects occur? We will have other important determinations. I think we were talking about emergency episodes. I think the criteria can be very helpful in saying that at this predicted level these are the kinds of effects that could be expected to occur. We will not confine our interests to just trying to determine how low or at what point do effects begin. It would be a scale where we will attempt to show on the best information we can get that these kinds of effects occur at these dose levels.

Mr. DADDARIO. You can not conclude from that, can you, that the problem might be solved by just having a capability to handle episodic effects and forgetting about these lower levels?

Dr. BLOMQUIST. No, indeed. I hope that I didn't imply that. No. Indeed not.

I am not sure that I understand your question. We are attempting to determine the effects so that we can say the effects are noticed at as low concentration as this. Above that, we find another kind of effect.

Mr. DADDARIO. I wanted to be sure of what you said.

What do you expect this will take so that you can be able to say to us that there is an effect on health at such and such a level?

Dr. BLOMQUIST. I am hoping that we can publish criteria within this calendar year on the ones that I have mentioned on our drawing board. I hope that we can get those out in the year 1968.

Am I answering your question?

Mr. DADDARIO. Yes.

What does the situation, as you see it at the moment, appear to be tending to? Are we correct in assuming that there are ill effects? Is there some substance to the validity of those who believe that the ill effects of air pollutants are extremely small to health?

Dr. BLOMQUIST. I think I would mention two points that are the most difficult in our experience: One would be that we are attempting to develop a curve or a linear relationship between effects and concentration in time. The research that is available does not always give us the precise points on this curve or line.

This is one of the biggest problems, the lack of objective data for all these points that we would like to be able to answer.

Then I think another big problem we are having is just how do we express the interpretation in the light of the criticism that we have had on the SO_x document? I think it has been suggested that there are differences of opinion on interpreting the data. I think that you made reference to it earlier, that you can get a group of highly competent scientists together, but the same facts do not always lead everyone to the same conclusion.

This is particularly true when we are trying to determine the critical level at which effects of significance occur. This is mostly due to two factors: One is the lack of precise knowledge on every point and the other is a difference in interpretation.

Mr. DADDARIO. Does that suggest when you publish this criteria it will leave something to be added which will necessitate additional research?

Dr. BLOMQUIST. I think this is true. I think we have to recognize this is a growing science and that the last word is not out now.

We must plan and we have planned that criteria will be revised from time to time. I don't think I would like anyone to feel that criteria are established now and forever. Obviously, with new information, additional facts will need to be considered as time goes on.

Mr. DADDARIO. Doctor, I don't often get into Mr. Bell's State of California, but the California State Department of Health recently published a report which said, and I quote: "Although smog is known to have serious adverse health effects, it is not a causative factor in lung cancer."

Would you agree it is not, that that is based on proper medical testimony?

What causative effects does it have on other types of diseases, if any? Is there one of those areas where you just have got to come to certain conclusions based on information——

Dr. BLOMQUIST. I think this is one of the gray areas. I think it is, for the facts I mentioned before, the data we have, but I think there is also a difference of opinion as to what you mean by cause.

I think in terms of disease we are generally taught to think that a single etiological agent directly causes a clinical entity, TB being one; you have to have the tubercle bacilli to get TB. I think what we are dealing with here in many situations are conditions of multiple causative factors, multiple etiology. Some of them may be primary and some may be secondary.

I think part of the controversy gets into what we are talking about as a cause. I think the major issue is that a direct cause——

Mr. Daddario. What do you see that we need to do in order to be able to come to such a clear understanding about this or to a much clearer one than presently exists. Can we eliminate this confusion and have a level of confidence about the criteria established by which people can then move ahead and get support and be willing to act under emergencies as they arise?

Dr. Blomquist. I am compelled to say that the first thing I think is better facts. I think every effort toward research to get the facts should be the primary objective.

Mr. Daddario. As you develop your criteria, you say you have certain flaws in it. What does it lead you to conclude as to how much more information you ought to have and as a medical man how you ought to go about getting it?

Dr. Blomquist. I think that one of the major advantages of going through what we are doing in reviewing the literature and evaluating it, is that we are better able to point out what questions should be given priority and further research. I think this will be one of the major benefits of our criteria documents.

I think what we will have to do is to be willing to say that we will do the best we can with the facts we have. That does not mean we do not do anything. I do not think that we can delay and delay because we do not have the conclusive facts.

Mr. Daddario. In which direction should we go? Should we approach this medical question from the least common denominator point of view? As an example, I understood Dr. Bennett yesterday to say air pollution does not cause disease but it aggravated health conditions of persons already diseased or weakened. Do you agree or disagree with that? How do we establish whether your position prevails or whether that of the Office of the Science Adviser to the President prevails?

Dr. Blomquist. I think we want action.

I would think action is necessary whether it aggravates a disease or causes it, I am thinking——

Mr. Daddario. Wouldn't it have a great deal of effect on what we are willing to pay if we could know that it does have an ill effect at a quicker level than we expect, or if we can understand that it does not? If it does in fact aggravate those who have already some kind of an illness, we would then approach it in a different way altogether?

Dr. Middleton. Are we speaking of the point of mixture and the fact we have direct and indirect and additive effects? I think that is the point Dr. Blomquist is trying to bring out.

Mr. Daddario. Of course, we are. That is the reason why it is so important at this stage of the game we know as much as possible about what we are doing, because it has, as Dr. Middleton suggests, so many complications. My fear is that we could easily come to the conclusion that it just aggravates rather than causes, and therefore establish a criteria which is not as good as it ought to be.

Dr. Blomquist. It worries me.

Mr. Daddario. It worries you, too?

Dr. Blomquist. Yes.*

Mr. Daddario. Dr. Blomquist, this is a matter about which this committee has been greatly concerned.

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*See page 115 for an additional statement by Dr. Blomquist.

Hearings we held some time back indicate we ought to be concerned. I hope we might have the opportunity to submit a series of questions about this. I think this is an important part of these particular hearings.

It may be necessary for you to come back, but we will try to see whether we can establish this for the record.

Dr. Blomquist. I would be glad to.

Dr. Middleton. We are very grateful for your real concern.

Mr. Daddario. We would next like to hear from Dr. Hibbard. Dr. Hibbard is an old friend so I have been able to hold him here until the end.

Dr. Hibbard and I went to Wesleyan together. We were in the same class and have had a long friendship. I am pleased he is with the Bureau of Mines. I know of his ability and competence.

While I apologize for the late hour I hope he might summarize his statement and then we can see where we go from there.

(The biography of Dr. Hibbard follows:)

DR. WALTER R. HIBBARD, JR.

Dr. Walter R. Hibbard, Jr., internationally known metallurgical engineer, has been director of the Bureau of Mines since December 1, 1965, following his appointment by President Lyndon B. Johnson in October of that year.

Dr. Hibbard's selection to head the Government agency charged with the major responsibility for the conservation and development of the Nation's mineral resources came after notable successes in earlier careers in education and research and development, and in directing metallurgy and ceramics research for one of America's largest industrial concerns.

Born in Bridgeport, Conn., on January 20, 1918, Dr. Hibbard was graduated from Wesleyan University, Middletown, Conn., in 1939, and received a Doctor of Engineering degree from Yale University in 1942.

Following his military service in World War II as a naval officer attached to the Bureau of Ships, he joined the faculty at Yale as an Assistant Professor and later became Associate Professor.

Dr. Hibbard's growing reputation in the teaching and research fields attracted the attention of industry, and in 1951 he was recruited by the General Electric Company for its Research and Development Center in Schenectady, N.Y. There he progressed to the position of Manager of Metallurgy and Ceramics Research directing a broad range of fundamental and applied research projects, a position he held when selected to become Director of the Bureau of Mines.

Dr. Hibbard's achievements in such fields as the plastic deformation of metals and the metallurgy of copper and its alloys have won him wide recognition from many professional societies. In 1950 he received the Raymond Award of the American Institute of Mining, Metallurgical, and Petroleum Engineers. From 1957 to 1961 he served as director of the Institute, and in 1967 he is serving as its President. He recently was named by AIME to receive the Institute's James Douglas Gold Medal, awarded for his notable career. For many years a registered professional engineer, Dr. Hibbard has served as President of the Metallurgical Society of the AIME, and is a past chairman of the Society's committees on the metallurgical profession and on engineering management. In January 1963, he was one of ten eminent metallurgists elected to the newly created grade of Fellow of the Metallurgical Society. In addition, Dr. Hibbard belongs to the British Institute of Metals and the New York Academy of Sciences, and is a fellow of both the American Academy of Arts and Sciences and the American Association for the Advancement of Science. He also is a member of the Materials Advisory Board of the National Academy of Science, and was recently its Chairman. In 1966 he was elected to the newly organized National Academy of Engineering.

Dr. Hibbard is the author of more than 70 scientific papers and has been widely recognized as a major contributor to the science of metallurgy. In 1957, he was a member of the exchange delegation of United States metallurgists visiting the Soviet Union.

He has been elected to many honorary and professional fraternities including Phi Beta Kappa, Sigma Xi, Alpha Chi Sigma, and Gamma Alpha. He also holds an honorary Doctor of Law degree from the Michigan Technological University, Houghton, Michigan.

Dr. and Mrs. Hibbard have three children and reside in Rockville, Md.

STATEMENT OF DR. WALTER R. HIBBARD, DIRECTOR, BUREAU OF MINES, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY DR. HARRY ALLEN, ASSISTANT DIRECTOR FOR MINERAL RESEARCH

Dr. Hibbard. I would like to point out that our mission and responsibility in this important problem area is for research on the control, at the source, of pollutants produced as a result of the production, processing, handling, and utilization of the Nation's mineral and mineral fuels resources. Authority for conducting such research derives from the Bureau's organic act which states that scientific and technologic investigations shall be conducted on the extraction and utilization of mineral substances with a view to conserving resources through the prevention of waste, increasing safety, and on behalf of the Government to investigate mineral fuels. It is important that the science and technology and the economics are generated to assume an adequate supply of mineral raw materials and at the same time to maintain the quality of the environment or improve it in many cases.

Much of the pollution is the result of inefficiencies. If we had really effective processing and utilization, with efficiencies approaching 100 percent, pollution from this source would be reduced significantly.

Moreover, from the standpoint of conservation there is a need to do this.

We work very closely with the Department of Health, Education, and Welfare and with industry. Much of our effort is funded by the Public Health Service. We report regularly to PHS on our program in toto with regard to those aspects which are related to air pollution, and in particular we report quarterly on those activities funded by the Air Pollution Control Center.

Last August, when I testified before your subcommittee, I pointed out that there was a lack of technology. There was much scientific understanding but technology was missing.

I am very pleased to report that the efforts of government, industry, and universities have resulted in a substantial advance in the technical feasibility of controlling and abating some of these sources of pollution.

There are many ways one can attack the SO_2 problem. Many are in a demonstration or pilot stage. It is clear, for example, that automobile exhaust pollution can be solved technologically without changing the basic modes of transportation.

The question of——

Mr. Daddario. You say "can be." Do you find some fault with the present control techniques? Is it worth the estimated $500 million it is costing us in order to add such exhaust mechanisms?

Dr. **Hibbard.** I meant technically it is possible to put a device into existing designs of automobiles which will lower the exhaust approximately to the proposed 1970 standards.

The major unresolved aspect of this is the cost and how we get it to the public.

What I am saying is that the technology exists. The engineering is yet to come. This is a substantial advance from a year ago.

Mr. **Daddario.** When you say there is a substantial advance in the application of our technology, comparing your view of this with your testimony a year ago, do you see any increase which has taken place in this capability, one which allows you to believe that the increase in this application of technology capability will, in fact, be greater as we go along, or do you find obstacles which prevent our making such advances?

Dr. **Hibbard.** I think within the last year, due to the stimulus and recognition of the problem, there has been a very splendid increase in efforts of industry and of the Government. There is a lot less lipservice to the problem and a lot more action.

I believe these problems are technologically solvable, and I believe with the kinds of ingenuity and capability we have in the manufacturing, scaling up, and cost reduction of these devices, particularly in the automotive industry, there is no reason to believe that pollution abatement cannot be done on an economically acceptable basis.

We cannot do it tomorrow because there is a timelag associated with all engineering effort.

I think the other areas we are concerned with, for example, the problem of SO_2 from smelter stacks, with the price of sulfur advancing as it is and with the development of technology, many of the smelters in the West now have SO_2 control devices. The operators of these smelters do this because it is good business, and they are stimulated in this effort for the purpose of recovering sulfur as well as to abate pollution.

The other areas with which we are concerned have to do with control of the dust and particulate matter from the large tailings piles and waste heaps which are the products of mining. These problems have not been solved. I think we know technically what can be done to solve them. For example, one of the ways of keeping dust off a tailings dump is to wet it down and eventually grow vegetation on it.

I think in the case of some of the burning dumps in Pennsylvania, old spoil banks of coal mines, we know technically what to do to put out the fire. Nevertheless, the cost of doing this is going to be very large, at least if we do it using the technology we know today.

The problem with respect to dumps, therefore, is how either to improve our technology to reduce the costs or how to take the technology we have and apply it at today's costs.

Mr. **Daddario.** Which ought we to do, use our present knowledge and apply it, or develop new knowledge—or both?

Dr. **Hibbard.** What we would like to do is to add to the technology so it would be economic to rework these dumps, and to find values in them which would pay for the costs of restoring the land by moving them away or otherwise disposing of them.

In some of the spoil banks and tailings dumps out West, we are finding ways of doing this. We are analyzing them to see if there is enough silver, gold, or copper or whatever other values they might contain to make it worth while to rework them. Then we can dispose of them at the same time.

In the case of the burning coal banks in Pennsylvania we have scratched our heads and looked as far as we can for solutions, but these dumps are gigantic. There are two of them, one containing 8 million cubic yards and the other with 6 million cubic yards and both are burning.

Just to truck it away will cost about $1 a cubic yard.

The economics of this thing will require much more attention.

Mr. DADDARIO. Are you developing an internal manpower capability so that you can foreseeably create this kind of capability? What are your limitations here?

Dr. HIBBARD. The whole question is one of urgency. In many of these problems the greater the effort the sooner the answer will come.

I think in our own organization we have the manpower to do this in an orderly way at a certain rate. If that is not soon enough then we ought to have more manpower.

I think this is also true with regard to Dr. Middleton's staff.

Aside from the technology itself it takes a certain length of time and a certain technical capacity to actually apply the remedies and preventive devices to industry or to an automobile.

Here again we may not have countrywide the total capability to do this as fast as we may wish.

The answer to you is the tradeoff between time and effort.

In my initial statement I said I thought we would solve these problems. The whole question is one of time.

Mr. DADDARIO. When you were talking about automobiles and the ability to take what we have and within a reasonable period of time do something about it, it makes me wonder what we do about the situation as it presently exists. If a truck is not maintained properly and is allowed to run around in the streets, say, it can overcome by its presence everything else we have done in thousands of cases. What steps are we taking in order to eliminate this particular problem? If we do not do that we are really spending a great deal of money to accomplish nothing.

Dr. HIBBARD. That is a real tough one. You can do things temporarily when the pollution problem is serious in a particular area. You can divert from the use of coal to natural gas. You can ask people not to drive cars into town, and so on. You can tell all the apartment house owners to stop incinerating trash for a period of time. But how to handle these problems on a more permanent basis is really a question of what we are willing to pay. This is not a dollar payment but a payment in terms of convenience and capability of doing things.

I am not sure that answers your question.

Mr. DADDARIO. It gets at it except that it does appear that the mechanisms presently planned in the automobile area work fine when installed. However, unless they are maintained you soon get back to the level where that vehicle would have been if that additional mechanism had not been put on the car.

Dr. Hibbard. Technology is trying to find ways of doing this so that these mechanisms will not deteriorate so soon.

One of the devices we have been using is actually developed by Du Pont. It has been operated 50,000 miles by the Du Pont Co. without serious deterioration.

The other question is really a regulatory one. An alternative, for example, is to have a car inspected every month or every 2 weeks. This is why I say it is a matter of tradeoff with what you are willing to pay. If you are willing to pay for it in terms of inconvenience or cost in this way you can put it into effect very promptly. If the public is not willing to go through the bother of inspections in those periods which we believe to be critical then that is something else.

Mr. Daddario. Dr. Middleton, what does your experience tell you about that particular problem?

Dr. Middleton. The motor vehicles that are sold nationally beginning in the fall of 1967, the 1968 models, the certificates of conformity awarded to the automotive industry for new vehicles, and Dr. Hibbard is making a very critical distinction there—authority vested in the Department of Health, Education, and Welfare is for new motor vehicles and engines—these certificates are awarded based on the lifetime of the vehicle such that a car, authorized as being in conformity, is manufactured, based on the samples tested, and that it will last within the limits imposed.

That is to say that the test procedures, the durability testing, and the amount of maintenance required are such that there is every assurance that these vehicles will be in compliance, and by way of some information on this, perhaps, we can give you some facts.

Let me say that in the testing of motor vehicles—I am trying to find that information.

Mr. Daddario. Why not give us your guess as you remember it at this point?

Dr. Ludwig. The surveillance tests that have been conducted over the several years since cars with devices, which have been required in California since 1966 and 1967, would indicate that they are exceeding slightly the 275 parts per million and the 1½ percent CO.

Whether this is 285 and 1.55 or something like this I cannot recall exactly.

Mr. Daddario. You mean better than?

Dr. Middleton. No, do not meet.

Dr. Ludwig. Do not meet the standards. They are slightly above the standards after 1 or 2 years of deterioration.

It is difficult to extend this into the future because the only way you can get car owner mileage on automobiles is to wait to see what happens in the third year.

Mr. Daddario. It would be difficult for the owner to come to a judgment as to whether or not his vehicle is meeting the standard or not.

Dr. Middleton. These vehicles are actually run 50,000 miles for durability tests. Every 4,000 miles they are measured.

From this we have a decay factor which tells us whether this system will last for the lifetime of the vehicle, expected to be 100,000 miles.

This is the data that I think will be of interest to you.

From the present certification data for the 1968 models we have found that 25 percent of the 1968 model year vehicles to be sold have been certified at less than 180 parts per million—our present standard is 275 hydrocarbon—and 1 percent CO. Our present standard is 1½. There is 25 percent capability, so there is technical capability of being better than now.

As to the durability and how well these cars last in the hands of private ownership let me point this out—90 percent of these same cars, 1968 models, to be sold have been certified with emission levels that are 225 parts per million hydrocarbons, 50 parts per million below the standard, and 1¼ percent CO. So that these cars in fact, with the test procedures prescribed, do meet these standards for the lifetime of the car with the kind of maintenance that the motor vehicle producer normally expects.

That is to say that there is not the need with the 1968 models—perhaps Dr. Hibbard clarified this—new systems, new cars with the new systems, there is assurance that these systems will last the lifetime of the car with minimum maintenance, normal maintenance.

To be assured that this is the case the Federal Government and the Congress has authorized us to develop inspection stations. This will be done in conjunction with the Department of Transportation in conjunction with the Highway Safety Act, so that we can be assured States will have inspection systems to see that these cars, in fact, are maintained adequately.

In addition we will have our own surveillance techniques in several areas to see if in passenger car use these are maintained.

The difficulty here is that even though this is real, possible, and now is in effect, an average car lasts 10 years and goes 100,000 miles. We speak rather bravely about how well we are controlling motor vehicle pollution. We are controlling one-tenth a year. At that we are curtailing only about 55 to 60 percent of the total emissions. Therefore much more needs to be done than now is being done.

One then is tempted, as Dr. Hibbard suggests, to deal with the used car and what systems are in vogue there. This may be a much more complicated matter because it means taking your car, mine, which is not now equipped——

Mr. Daddario. Mine is not a 1968.

Dr. Middleton. And going somewhere and having equipment put on which is many hours of labor and special equipment.

The feasibility, even though you have the technical skill, for putting these on used cars seems remote.

Mr. Daddario. The impetus you have given to the need in this direction already has caused development of certain mechanical capabilities. Wouldn't you foresee that because of the market potential here, that you will and can stimulate development of some mechanisms which ought soon to be available in the consumer market for used cars?

Dr. Middleton. Whether this can be developed for used cars in the time frame we would like to see is a question.

Certainly innovation typically comes from outside the particular industry. We have many people who have ideas. The patentable idea of Du Pont, which Dr. Hibbard mentioned, is one of those. Whether this device can be applied to all populations of cars because of the nature of the manifold exhaust system and the specific dimensions of it on a broad scale is an issue to be settled.

I am suggesting that the applicability of our known effective control system to used cars seems almost impossible, but if we can do this on a lab scale and check it out on existing cars then there may be further technical improvements to allow broad-scale application.

Dr. **Hibbard.** I think this is the crux of the problem. For example, even with a 1968 car the first 50,000 miles of it will be driven with good maintenance.

Probably the second 50,000 miles will be driven with significantly less maintenance because it becomes substantially a different kind of car.

Of the large number of cars that are now on the highways, a significant number are in the second category. Really, then, the major inroad to the problem goes back to what we can do—with the cars that are on the road. I see no alternative than the one I mentioned before. You have to decide what you are willing to pay for it. Will you force these people to either fix up their cars or take them off the roads?

Will you insist on a series of fairly careful inspections? You cannot tell by looking.

For example, these concentrations of various exhaust components are not something you can determine by looking at the exhaust. These are more subtle. Therefore a car can be on the road having no apparent exhaust effluent and yet be pouring out CO without anybody knowing it. This is what I meant.

Mr. **Daddario.** I have already kept all of you far beyond the time I should have.

I am going to pose one further question. I will not ask you to answer it here but I will ask you to provide the answer for the record.

The 1967 Air Quality Act gives the Secretary of Health, Education, and Welfare authority to prescribe standards for auto emissions which in his judgment cause pollution. This is section 202(a). But in the case of other sources, criteria and recommended control techniques must be published before standards are set.

In the case of carbon monoxide, if we do not bypass the criteria set by Federal standards and assuming the Federal Government is following California's lead, what is the basis for that State's choice of carbon monoxide emission limitations?

Please provide the answer.

Dr. **Middleton.** Very simply provided.

(Information requested is as follows:)

BACKGROUND INFORMATION ON PROCEDURES USED IN DEVELOPING POLLUTION CONTROL STANDARDS FOR MOTOR VEHICLES—CALIFORNIA

The State of California established its initial ambient air quality and motor vehicle emission standards in December 1959. They were revised in October 1964. California's standards were based on evaluation of available evidence reflecting the relationship between pollutants and their adverse effects on health, vegetation, and visibility. This was required by State statute. Section 426.1 of the California Health and Safety Code provides: "The standards shall be so developed as to reflect the relationship between the intensity and composition of air pollution and the health, illness, including irritation to the senses, and death of human beings, as well as damage to vegetation and interference with visibility." This language refers to the establishment of air quality standards. Section 426.5, which refers to maximum allowable standards of emissions of exhaust contaminants from motor vehicles, states that these emission standards must be "compatible with the preservation of the public health including the prevention of irritation to the senses, interference with visibility and damage to vegetaton." Provision is made in these statutes for revision of the standards. A copy of "California Standards for Ambient Air Quality and for Motor Vehicle Emissions" is enclosed to indicate in more detail the factors considered in establishing the standards and the justifications for the specific values established.

California's motor vehicle standards were derived from the State's air quality standards and data concerning motor vehicle emissions[1]. The emission standards set in 1959 were calculated from the following elements[2]:

1. Determination of the total emissions from all sources and the concentration emitted by the vehicle, and extrapolation of the data to a reasonable time period in the future. The year 1970 was selected.
2. Evaluation of current levels of atmospheric pollutants, those expected in 1970 and levels in the air quality standards which describe the relationship of air pollution effects and concentrations.
3. Calculation of the necessary reduction of pollutant emissions to maintain the desired air quality. This procedure indicated that motor vehicle hydrocarbons should be reduced by 80 percent and carbon monoxide by 60 percent.

In October 1964, the State of California revised its standards for emission of hydrocarbons and carbon monoxide from motor vehicles using data on vehicular emissions that had been developed since 1959 and using 1980 as the target year in which to restore smog-free air. These new standards were applicable, generally, to 1970 model year vehicles and were considerably more restrictive than the standards originally promulgated in 1959.[3] Recent estimates of the California Department of Public Health indicate that even more restrictive standards will be required if clean air is to be maintained in the years 1990 and 2000.[4]

FEDERAL GOVERNMENT

The Clean Air Act Amendments of 1965 directed the Secretary of Health, Education and Welfare to prescribe standards applicable to air pollutant emissions from new motor vehicles which, in his judgment, cause or contribute to, or are likely to cause or contribute to air pollution which endangers the health or welfare of any persons. The Secretary was directed to give appropriate consideration to technological feasibility and economic costs of vehicle emission control. In the Clean Air Act of 1963, the Secretary was directed to compile and publish air quality criteria whenever he determines that there is a particular air pollution agent (or combination of agents) in the air producing effects harmful to the health or welfare of people.

In the normal course of carrying out responsibilities specified in the Clean Air Act and the original Federal air pollution control law of 1955, the Department had been conducting a variety of research projects to determine the effects of air pollutants on health and welfare and had been supporting the work of others in this field through grants and contracts. Consideration of the results of this work, along with the results of work done by many investigators, both since 1955 and earlier had, by 1966, made it possible to develop reasonably good estimates of levels of air pollutants which would be necessary to prevent harmful effects on the public health and welfare. This information, along with data on existing pollution levels in a substantial number of communities clearly indicated that pollution levels associated with pollutants emitted by motor vehicles were in excess of desirable levels in many communities. All estimates of future pollution levels indicated that the situation would worsen rapidly because of the growth of urban communities and increased usage of vehicles, unless action was taken to control pollutant emissions from vehicles. On the basis of all this information, and in consideration of then available means for reducing emissions from vehicles, and their costs, standards were promulgated in March of 1966 for control of pollutants from certain motor vehicles, beginning with the 1968 model year.

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[1] Technical Report of California Standards for Ambient Air Quality and Motor Vehicle Exhaust; California Dept. of Public Health, Berkeley, Calif., 1960.

[2] Maga, John A. "Prepared Discussion: The Rationale of Motor Vehicle Pollution Contriol" in Proceedings, National Conference on Air Pollution, Dec. 10–12, 1962. USDHEW, PHS, USGPO, 1963 (pp. 68–70).

[3] State of California, Dept. of Public Health, Bureau of Air Sanitation, "Clean Air Quarterly" *11*, March 1967.

[4] Calif. State Dept. of Public Health "Progress Report—Possible Future Motor Vehicle Emission Standards" presented to the California Motor Vehicle Pollution Control Board, May 10, 1967.

Since 1966, the Department has continued and accelerated its work on determination of the adverse effects of air pollutants on health and welfare, means for control of pollutants from motor vehicles, measurement of pollution levels in a variety of communities, estimation of probably future pollution levels, and development of air quality criteria. Such criteria are being prepared for carbon monoxide, hydrocarbons, and nitrogen oxides. By the later part of 1967, sufficient knowledge had been acquired to provide a reasonable basis for selection of air quality goals for community atmospheres and to relate these to presently existing and probable future pollution levels. The air quality goals used were generally consistent with those recommended by the Advisory Panel on Electrically Powered Vehicles to the Commerce Technical Advisory Board of the U.S. Department of Commerce in a report supported by nine Federal agencies [5, 6]. On the basis of all available information, it was determined that the motor vehicle emission standards promulgated in 1966 would not provide the degree of emission reduction needed to ensure air quality in keeping with the selected air quality goals. Therefore, after consideration of technological feasibility and economic costs, revised vehicle emission standards were proposed by the Secretary of HEW in the Federal Register on January 4, 1968. When adopted and implemented, these standards will provide for important reductions in emissions and pollutant levels in the ambient air. However, in view of the continuing growth of urban centers and vehicle usage, it is expected that even more restrictive standards will be needed in the future. Further developments in emission control technology will be needed.

CALIFORNIA STANDARDS FOR AMBIENT AIR QUALITY AND FOR MOTOR VEHICLE EMISSIONS

A COMPILATION OF STANDARDS SET BY THE CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH BETWEEN DECEMBER 1959 AND OCTOBER 1965

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Sections of the Health and Safety Code.
Ambient Air Standards.
Motor Vehicle Emission Standards:
- **Definition of Terms;**
- **Exhaust Emissions;**
- **Crankcase Emissions;**
- **Fuel Tank Emissions;**
- **Carburetor Hot Soak Emissions;**
- **Smoke Emissions.**

SECTIONS OF THE HEALTH AND SAFETY CODE RELATING TO THE ENACTMENT OF STANDARDS FOR AMBIENT AIR QUALITY AND FOR MOTOR VEHICLE EMISSIONS

§ 426.1 *Standards for quality of air*

The State Department of Public Health shall, before February 1, 1960, develop and publish standards for the quality of the air of this State. The standards shall be so developed as to reflect the relationship between the intensity and composition of air pollution and the health, illness, including irritation to the senses, and death of human beings, as well as damage to vegetation and interference with visibility.

The standards shall be developed after the department has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The department shall publish such notice of the hearings as it determines to be reasonably necessary.

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[5] U.S. Dept. of Commerce "The Automobile and Air Pollution—A Program for Progress, Part I." Report of the Panel on Electrically Powered Vehicles, R. S. Morse, Chairman. Oct. 1967. (USGPO).

[6] U.S. Dept. of Commerce "The Automobile and Air Pollution—A Program for Progress, Part II." Report of the Panel on Electrically Powered Vehicles, R.S. Morse, Chairman. Dec. 1967. (USGPO).

The department, after notice and hearing, may revise the standards, and shall publish the revised standards, from time to time. (Added Stats. 1959, c. 835, p. 2885, § 1, effective June 8, 1959.)

§ 426.5 *Maximum allowable standards of emissions of exhaust contaminants from motor vehicles; determination; public hearings; notice; revision*

It shall be the duty of the State Director of Public Health to determine by February 1, 1960, the maximum allowable standards of emissions of exhaust contaminants from motor vehicles which are compatible with the preservation of the public health including the prevention of irritation to the senses, interference with visibility and damage to vegetation.

The standards shall be developed after the department has held public hearings and afforded an opportunity for all interested persons to appear and file statements or be heard. The department shall publish such notice of the hearings as it determines to be reasonably necessary.

The department after notice and hearing may revise the standards, and shall publish the revised standards, from time to time. In revising the standards the department shall, after February 1, 1960, take into account all emissions from motor vehicles rather than exhaust emissions only.

Whenever the department revises the standards it shall submit a copy of such revised standards to the Legislature if the Legislature is in session, or to the Senate Fact Finding Committee on Transportation and Public Utilities and the Assembly Interim Committee on Transportation and Commerce if the Legislature is not in session, and such revised standards shall not become effective until the 31st day after such submission. (Added Stats. 1959, c. 200, 2091, § 1, as amended; Stats. 1960, 1st Ex. Sess., c. 36, p. 380, § 1; Stats. 1965, c. 2031, p. —, § 1 urgency, eff. July 23, 1965.)

AMBIENT AIR STANDARDS

In establishing the air quality standards which follow, the State Department of Public Health aimed at providing a sound basis for efforts to control or abate sources of atmospheric pollution. With the great variety and wide distribution of emission sources, air pollution control may indeed be costly, and minimum levels of some pollutants are inevitable. It was important, therefore, to estimate at what level certain specified effects begin to occur for the various pollutants. These estimates are the basis for the standards.

It was agreed from the outset that any standards set must be based on sound data and concurred in by scientists in the air pollution and related fields. The standards relating to human health and well-being were based on the groups of persons in the population who are most sensitive to air pollution effects provided such groups be definable in terms of age and medical status.

The following possible effects of community air pollution on sensitive groups of people were recognized:

1. Acute sickness or death.
2. Insidious or chronic disease.
3. Alteration of important physiological function.[1]
4. Untoward symptoms.[2]
5. Discomfort from air pollution sufficient to lead individuals to change residence or place of employment.

The following effects of community air pollution upon sensitive types of crops were also recognized:

1. Acute damage leading to unmarketability.
2. Insidious or chronic effects, leading to impaired yield.
3. Alteration of fundamental biochemical processes without overt damage.

The effects of air pollutants vary both in kind and in severity. The seriousness of the effect determines the urgency of control. A graded set of standards was established which recognized this relationship. Three levels of air pollutants were defined as follows:

I. "Adverse" Level. The first effects of air pollutants are those likely to lead to untoward symptoms or discomfort. Though not known to be associated with the development of disease, even in sensitive groups, such effects are capable of disturbing the population stability or residential or work communities. The "adverse" level is one at which eye irritation occurs. Also in this category are levels of pollutants that lead to costly and undesirable effects other than those on humans. These include damage to vegetation, reduction in visibility, or property damage of sufficient magnitude to constitute a significant economic or social burden.

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[1] By important physiological function is meant function such as ventilation of the lung, transport of oxygen by hemoglobin, or dark adaptation (the ability to adjust eye mechanisms for vision in partial darkness).

[2] By untoward symptoms is meant symptoms which in the absence of an obvious cause, such as air pollution, might lead a person to seek medical attention and relief.

II. "Serious" Level. Levels of pollutants, or possible combination of pollutants, likely to lead to insidious or chronic disease or to significant alteration of important physiological function in a sensitive group, define the "serious" level. Such an impairment of function implies a health risk for persons constituting such a sensitive group, but not necessarily for persons in good health.

III. "Emergency" Level. Levels of pollutants, or combination of pollutants, and meteorological factors likely to lead to acute sickness or death for a sensitive group of people, define the "emergency" level.

"The net effect of air pollutants depends on a number of modifying factors. It cannot be predicated reliably from the mere specification of a concentration of a pollutant at one place at one time. It is known that particle size may modify the toxicity of inhaled toxic substances; moreover, the mere presence of particles, whether or not in themselves toxic, may strongly intensify the irritant action of gases such as sulfur dioxide. In some cases, present knowledge was sufficient to take some of these factors into account in setting standards. In others, more information will be required before standards can be set.

It was necessary in some instances to use indirect indicators in order to specify pollutant levels. For example, reliable analytical methods have been widely used to measure levels of "oxidant." Data from such measurements provide useful correlations with eye irritation, visibility and crop damage, despite the fact that "oxidant" does not directly measure the specific substances that produce these effects. Until the specific substances have been identified and adequate procedures for their measurement developed, "oxidant index" will be used to define these effects at the advese level. In the future it may be practical to utilize a biological indicator of air pollution.

Standards set for single pollutants alone are not necessarily applicable to combinations of pollutants, nor to physiological effects under unusual weather conditions, or to pollutants occurring in aerosol form or when in combination with aerosols. These factors may complicate the effects of single pollutants. In addition several pollutants may have similar effects. For these reasons no single level of a given pollutant ordinarily without effect at that level should be interpreted as a guarantee that levels below that point are safe or free from effect.

The standards of air quality are not intended to provide a sharp dividing line between air of satisfactory quality and air of unsatisfactory quality. The numbers represent the approximate levels at which certain definite effects begin to occur. It follows that pollution levels below those shown in the standards should not ordinarily produce the stipulated effects defined at each level.

In addition to the above matters, the following technical factors were also considered in setting standards: (1) methods of measurement of the pollutant, (2) criteria for selection of the most susceptible group in the community, and (3) time of exposure to the pollutant.

Two time-periods were considered: a time-weighted hourly average and an average for an eight-hour period. Concentrations and time periods given in the table refer only to levels for which data are felt to be reliable and suitable for application without excessive assumptions. The footnotes to the table indicate the substances which need additional data before they can be entered in the table of standards.

The entry, "Not Applicable", indicates that under conditions of community air pollution it is extremely unlikely that the defined effects occur.

It is the intent of the Department to adopt standards for additional substances in the future.

The values entered here are determined on a substantially different basis than the industrial exposure standards. These values are, therefore, not appropriate for application in industrial hygiene.

The bases upon which standards are set are indicated by items enclosed with parentheses.

The Department will interpret these standards to those agencies responsible for air pollution control. In interpreting these standards, the sites and conditions of air sampling should be so chosen as to realistically represent the exposures of persons and property which might be affected.

TABLE OF STANDARDS FOR AMBIENT AIR QUALITY

Pollutant	Adverse level[1]	Serious level[2]	Emergency level
Photochemical pollutants (hydrocarbons, ozone, oxidant, and photochemical aerosols).	Oxidant index, 0.15 p.p.m. for 1 hour by the potassium iodide method (eye irritation, damage to vegetation, and visibility reduction).	(4 5)	(4 6).
Nitrogen dioxide	0.25 p.p.m. for 1 hour (coloration of the atmosphere during daylight hours).	3 p.p.m. for 1 hour (bronchoconstriction).	(7).
Carbon monoxide	Not applicable	30 p.p.m. for 8 hours, or 120 p.p.m. for 1 hour (interference with oxygen transport by blood).	(8).
Sulfur dioxide	1 p.p.m. for 1 hour or 0.3 p.p.m. for 8 hours (damage to vegetation).	5 p.p.m. for 1 hour (bronchoconstriction.	10 p.p.m. for 1 hour (severe distress to human subjects).
Hydrogen sulfide	0.1 p.p.m. for 1 hour (sensory irritation).	(9)	(10).
Sulfuric acid	(11)	(11)	(12).
Ethylene	0.5 p.p.m. for 1 hour or 0.1 p.p.m. for 8 hours (damage to vegetation).	Not applicable	Not applicable.
Hydrogen fluoride	(13)	(14)	Do.
Lead	Not applicable	(15)	(15).
Particulate matter	Sufficient to reduce visibility to less than 3 miles when relative humidity is less than 70 percent.	Not applicable	Not applicable.
Carcinogens	Not applicable	(16)	Do.

[1] Level at which there will be sensory irritation, damage to vegetation, reduction in visibility, or similar effects.

[2] Level at which there will be alteration of bodily function or which is likely to lead to chronic disease.

[3] Level at which it is likely that acute sickness or death in sensitive groups of persons will occur.

[4] Hydrocarbons are a group of substances most of which, normally, are toxic only at concentrations in the order of several hundred parts per million. However, a number of hydrocarbons can react photochemically at very low concentrations to produce irritating and toxic substances. Because of the large number of hydrocarbons involved, the complexity of the photochemical reactions, and the reactivity of other compounds such as nitrogen dioxide and ozone, it is not yet possible to establish serious and emergency levels for hydrocarbons. From the public health standpoint, the concentration of those hydrocarbons which react photochemically should be maintained at or below the level associated with the oxidant index defined in the adverse standard.

[5] Ozone, at 1 p.p.m. for 8 hours daily for about a year, has produced bronchiolitis and fibrositis in rodents. Extrapolation of these data to man is difficult. Functional impairment data have been reported; at 1.25 p.p.m. some effect is observed on residual volume and diffusing capacity. The variability of the tests was not reported. Additional data would be needed before a standard is set.

[6] A value of 2.0 p.p.m. of ozone for 1 hour may produce serious interference with function healthy persons and the assumption is made that this might cause acute illness in sensitive persons.

[7] Nitrogen dioxide, at concentrations above 2.5 p.p.m., causes acute damage to sensitive plants. 1 p.p.m. for 8 hours will produce significant growth reduction, expressed as fresh and dry weight, with no visible lesions of damage. High levels (150 to 220 p.p.m.) in short exposures produce fibrotic changes in the lungs of man that may end fatally.

[8] Given certain assumptions concerning ventilatory rates, acute sickness might result from a carbon monoxide level of 240 parts per million for 1 hour in sensitive groups because of inactivation of 10 percent of the body's hemoglobin. In any event it is clear that when a population exposure limit has been set for carbon monoxide, because of exposures from other sources, community air pollution standards should be based on some fraction of this limit.

[9] Hydrogen sulfide is not known to produce chronic disease in humans but there may be durable sequelae from acute exposures. The disagreeable odor may interfere with appetite in sensitive groups of persons at about 5 parts per million. At high concentrations loss of the sense of smell occurs. This has been reported at 100 parts per million for exposures lasting 2 to 15 minutes. Conjunctivitis and mild respiratory tract irritation have been reported at levels of 50 to 100 parts per million for 1 hour.

[10] Acute sickness and death with neurotoxicity may occur at concentrations of several hundred parts per million. It is very unlikely these levels will occur in community air pollution.

[11] A sulfuric acid mist level of 1 mg./M^3 with an average particle size of 1 μ will produce a respiratory response in man. It is not possible to generalize from this for all air pollution conditions, because under natural conditions, particle size will vary. Only with large droplets would sensory irritation be produced without other physiological effects.

[12] A level of 5 mg./M^3 of sulfuric acid mist for a few minutes produces coughing and irritation in normal individuals. Presumably, it could cause acute illness in sensitive groups of persons in a period of 1 hour.

[13] Hydrogen fluoride and other airborne fluorides settle upon and some are absorbed into vegetation. When forage crops containing 30 to 50 p.p.m. of fluoride measured on a dry-weight basis are regularly consumed over a long period the teeth and bones of cattle may show changes, depending upon age, nutritional factors, and the form of fluoride ingested. Such changes may or may not have any economic effect. Fluorides at these levels do not necessarily cause injury to the forage plants themselves. However, injury may be produced in certain species of vegetation upon long-term exposure to low levels of atmospheric fluorides.

[14] The irritating properties of hydrogen fluoride in experimental human exposure have been manifested by desquamation of the skin, at concentrations of 2 to 5 p.p.m. Mucous membrane irritation also occurs from hydrogen fluorides but quantitative data are not adequate to support a standard.

[15] It is clear that lead levels should be set on the basis of average values for long periods. While data are abundant concerning human response to 8-hour-a-day, 5-day-a-week exposures, data are insufficient for the effects of the continuous exposure inherent in community air pollution. While laboratory studies will be pursued with vigor, it becomes very important that local agencies collect data on existing lead levels. Since lead exposures are from multiple sources, community air pollution standards should be based on a portion of the total limit for population exposure.

[16] Carcinogens include a few organic compounds such as some polycyclic hydrocarbons and some metals such as arsenic and chromium. Studies on effects of such substances are currently underway, but there are not sufficient data at present to set standards. In the meantime, it is recommended that concentrations of carcinogens in air should be kept as low as possible.

MOTOR VEHICLE EMISSION STANDARDS

Motor vehicles are a major source of air pollution in the large metropolitan regions of California. Their exhaust contains large quantities of hydrocarbons, oxides of nitrogen and carbon monoxide. Hydrocarbons are also emitted from the crankcase, fuel tank and carburetor. Controlling the emissions of these contaminants from motor vehicles is an essential step in the control of photochemical smog.

Recognizing that control of motor vehicle emissions is a vital part in a total program to improve air quality in California, the State Department of Public Health established a set of standards for the various motor vehicle emissions. These standards provide a technical basis for control programs. The standards define acceptable limits for emissions from an "average" vehicle.

Essentially, the Department based the standards on conditions in Los Angeles. Since air pollution in Los Angeles is known to be the most severe in the state, measures that would provide satisfactory air quality there would be adequate for other regions in the state.

Hydrocarbons and oxides of nitrogen are directly involved in the photochemical reactions in the atmosphere that result in smog. Nitrogen dioxide can also be injurious to health, cause vegetation damage, and impart an undesirable color to the atmosphere.

Carbon monoxide does not participate in the smog reaction, but it is a toxic substance. At sufficiently high concentrations, it can cause sickness. Since more than 95 percent of the carbon monoxide in the atmosphere of Los Angeles is of vehicular origin, control of its emission from motor vehicles should effectively reduce the atmospheric concentration of this contaminant.

The smoke standard was established to provide a guide-line for controlling the local nuisance effect of vehicle smoke.

DEFINITION OF TERMS

Exhaust Emissions.—Exhaust emissions are defined as substances emitted to the atmosphere from any opening downstream from the exhaust manifold of a motor vehicle engine.

Crankcase Emissions.—Crankcase emissions are defined as substances emitted directly to the atmosphere from any opening leading to the crankcase of a motor vehicle engine. Crankcase gases which are conducted to the engine intake or exhaust systems are not included in the definition of crankcase emissions, but are defined as exhaust emissions.

Carburetor Emissions.—Carburetor Operating Losses: Carburetor operating losses are defined as the vaporized fuel emitted from the carburetor of a motor vehicle engine to the atmosphere while the engine is operating.

Carburetor Hot Soak Losses: Carburetor hot soak losses are defined as the vaporized fuel emitted from the carburetor of a motor vehicle engine to the atmosphere during the hot soak period, i.e., the period which begins immediately after the engine is turned off.

Fuel Tank Emissions.—Fuel tank emissions are defined as the vaporized fuel which escapes to the atmosphere from the fuel tank of a motor vehicle, except during tank filling.

EXHAUST EMISSIONS

The standards of emissions of motor vehicle exhaust contaminants are:

Hydrocarbons—275 parts per million by volume as hexane (0.165 mole percent carbon atoms).

Carbon Monoxide—1.5 percent by volume.

Oxides of Nitrogen—350 parts per million by volume as nitrogen dioxide.

However, effective January 1, 1970, the standards of emissions of motor vehicle exhaust will be:

Hydrocarbons—180 parts per million by volume as hexane.

Carbon Monoxide—1.0 percent by volume.

Oxides of Nitrogen—350 parts per million by volume as nitrogen dioxide.

Exhaust gas concentration shall be adjusted to a dry exhaust volume containing 15 percent by volume of carbon dioxide plus carbon monoxide. However, effective January 1, 1970, the exhaust gas concentration shall be adjusted by the ratio of $15/[\frac{1}{2}(\%CO)+\%CO_2+10(\%\text{ Hydrocarbon})]$.

Hydrocarbons are defined as the organic constituents of vehicle exhaust as measured by a hexane-sensitized nondispersive, infrared analyzer or by an equivalent method.[1]

Carbon monoxide shall be measured by a nondispersive infrared analyzer or by an equivalent method.

Oxides of nitrogen shall be measured by the phenoldisulfonic acid method or by an equivalent method.

The standards refer to a composite sample representing the driving cycle described as follows:

TABLE I[1]

Condition	Rate of speed change miles per hour per second	Percent of total time	Percent of total sample volume
Idle		15.0	4.2
Cruise (miles per hour):			
20		6.9	5.0
30		5.7	6.1
40		2.7	4.2
50		.7	1.5
Acceleration (miles per hour):			
0 to 60	3.0	1.1	5.9
0 to 25	2.2	10.6	18.5
15 to 30	1.2	25.0	45.5
Deceleration (miles per hour):			
50 to 20	1.2	10.2	2.9
30 to 15	1.4	11.8	3.3
30 to 0	2.5	10.3	2.9
Total		100.0	100.0

[1] If other test cycles are used, they must represent urban driving and the emissions must be relatable to the composite sample from the driving modes described in table I.

CRANKCASE EMISSIONS

The standard for motor vehicle crankcase emissions is: Hydrocarbons—0.1 percent by weight of the supplied fuel. The standard refers to a composite sample representing the modes of engine operation described as follows:

Mode of operation	*Percent of total time*
Idle	19
30 mph—16 inch mercury manifold vacuum	37
30 mph—10 inch mercury manifold vacuum	11
30 mph—2 inch mercury manifold vacuum	8
Deceleration	25

FUEL TANK EMISSIONS

The standard for fuel tank emissions is: Hydrocarbons—6 grams per day.[2]

CARBURETOR HOT SOAK EMISSIONS

The standard for carbuertor hot soak emissions is: Hydrocarbons—2 grams per soak.[3]

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[1] Some hydrocarbons, for example methane, ethane, propane, n-butane and acetylene, are not considered sufficiently reactive to produce photochemical smog effects. The Department is working on methods which measure the reactive organic compounds in exhaust and will restate the hydrocarbon standard in terms of reactive hydrocarbons when methods and data satisfactory to the Department are developed.

[2] The standard refers to emissions in a 24-hour day when the minimum temperature is 60°F. and the maximum is 90°F., and when the fuel tank is between one-fourth and one-half full, averaging three-eighths full. The standard was developed from data obtained when fuels averaging a Reid Vapor Pressure of approximately 9 were used, and when hydrocarbon emissions were collected in condensing traps at dry ice temperature. Equivalent methods and other conditions may be used if approved by the Department of Public Health.

[3] The standard refers to emissions from the carburetor of an automotive engine operated to an equilibrium coolant temperature of 180° F. minimum and when the ambient air temperature is from 85 to 95° F. minimum. The soak duration is one hour. The standard was developed from data obtained when fuels averaging a Reid Vapor Pressure of approximately 9 were used in the test vehicles, and when hydrocarbon emissions were collected in condensing traps at dry ice temperature. Equivalent methods and other conditions may be used if approved by the Department of Public Health.

SMOKE EMISSIONS

The standard for smoke emitted from a motor vehicle is:

a. The shade, or the equivalent opacity of the shade,[1] designated as No. 1 on the Ringelmann Chart;[2] or

b. The shade, or equivalent opacity of the shade, designated as Ringelmann No. 2, if the smoke is for a period not exceed five seconds at a time.

ADDITIONS TO TITLE 17, CALIFORNIA ADMINISTRATIVE CODE—ADOPTED BY THE CALIFORNIA STATE BOARD OF PUBLIC HEALTH, JUNE 10, 1966

ARTICLE 2. STANDARDS FOR MOTOR VEHICLE EMISSIONS

30570. Exhaust Odor and Irritation

The standards for exhaust odor and irritation are:

(a) The average intensity of odor as determined by subjective appraisal shall be less than the intensity from diesel vehicles with horizontal exhaust pipes representative of the diesels in use in 1966 and whose odorant concentrations have been reduced by at least 80 percent.

(b) There shall be no detectable eye, nasal or throat irritation to at least 75 percent of the panel.

(c) Exhaust odors that are different in quality from characteristic diesel odor shall be less objectionable to the panel than the odor from diesel vehicles with horizontal exhaust pipes representative of the diesels in use in 1966 and whose odorant concentrations have been reduced by at least 80 percent.

(d) The conditions for the appraisal are:

1. The odor and irritation panel shall consist of not less than 10 persons.
2. Appraisal of odor and irritation shall be made on a vertical plane ten feet distant from the exhaust outlet to either side of the motor vehicle parallel to the longitudinal axis. For vehicles with more than one exhaust outlet, the appraisal shall be made on a vertical plane parallel to the longitudinal axis at a horizontal distance ten feet from the midpoint of the exhaust outlets.
3. The exhaust gas shall be evaluated during the modes of idle and full throttle acceleration.
4. Other methods of odor appraisal or measurement may be used if approved by the Department of Public Health.

ADDITION TO TITLE 17, CALIFORNIA ADMINISTRATIVE CODE—ADOPTED BY THE CALIFORNIA STATE BOARD OF PUBLIC HEALTH, OCTOBER 21, 1966

ARTICLE 2. STANDARDS FOR MOTOR VEHICLE EMISSIONS

30520. Exhaust Emissions. (a) The standards of emissions of motor vehicle exhaust contaminants are:

1(Vehicles with engine displacement of 50 to 100 cubic inches: Hydrocarbon—410 parts per million by volume as hexane. Carbon Monoxide—2.3 percent by volume.

(2) Vehicles with engine displacement of 101 to 140 cubic inches: Hydrocarbons—350 parts per million by volume as hexane. Carbon Monoxide—2.0 percent by volume.

(3) Vehicles with engine displacement above 140 cubic inches: Hydrocarbons—275 parts per million by volume as hexane. Carbon Monoxide—1.5 percent by volume.

(4) Oxides of Nitrogen—350 parts per million by volume as nitrogen dioxide, for all engine displacements.

However, effective January 1, 1970, the standards of emissions of motor vehicle exhaust are:

Hydrocarbons—180 parts per million by volume as hexane.
Carbon Monoxide—1.0 percent by volume.
Oxides of Nitrogen—350 parts per million by volume as nitrogen dioxide.

(b) Exhaust gas concentrations shall be adjusted to a dry exhaust volume containing 15 percent by volume of carbon dioxide plus carbon monoxide. However, effective January 1, 1970, the exhaust gas concentrations shall be adjusted by the ratio of $15/[\frac{1}{2}(\%CO)+\%CO_2+10(\%\ \text{Hydrocarbon})]$.

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[1] Equivalent opacity is defined as the obscuration to an observer's view produced by smoke of any color that is equal to an obscuration by smoke of a shade specified in the Ringelmann Smoke Chart, published by the U.S. Bureau of Mines.

[2] As published by the U.S. Bureau of Mines, Information Circular 7718, August, 1955.

(c) Hydrocarbons are defined as the organic constituents of vehicle exhaust as measured by a hexane-sensitized nondispersive infrared analyzer or by an equivalent method.[1]

(d) Carbon Monoxide shall be measured by a nondispersive infrared analyzer or by an equivalent method.

(e) Oxides of nitrogen shall be measured by the phenoldisulfonic acid method or by an equivalent method.

(f) The standards refer to a composite sample representing the driving cycle described as follows:

TABLE I[1]

Condition	Rate of speed change miles per hour per second	Percent of total time	Percent of total sample volume
Idle		15.0	4.2
Cruise (miles per hour):			
20		6.9	5.0
30		5.7	6.1
40		2.7	4.2
50		.7	1.5
Acceleration (miles per hour):			
0 to 60	3.0	1.1	5.9
0 to 25	2.2	10.6	18.5
15 to 30	1.2	25.0	45.5
Deceleration (miles per hour):			
50 to 20	1.2	10.2	2.9
30 to 15	1.4	11.8	3.3
30 to 0	2.5	10.3	2.9
Total		100.0	100.0

[1] If other test cycles are used, they must represent urban driving and the emissions must be relatable to the composite sample from the driving modes described in table I.

Mr. Daddario. I expect we could continue here for some time but we will have a whole series of questions for you. We would appreciate your getting them to us. If there are any problems I am sure we can have our staff work them out.

Dr. Middleton. Thank you very much, sir. I enjoyed being with you.

Mr. Daddario. I appreciate ever so much your cooperation, and you all being here this morning.

(Dr. Hibbard's complete prepared statement is as follows:)

Prepared Statement of Walter R. Hibbard, Director, Bureau of Mines, U.S. Department of the Interior

My name is Walter Hibbard, and I am the Director of the Bureau of Mines, U.S. Department of the Interior. A biographical summary is available for the record if you so desire.

I am pleased to have the opportunity to participate in these hearings and to outline for you the activities of the Bureau of Mines that are directed toward resolution of the technical problems facing the Nation in its efforts to abate environmental pollution.

Our mission and responsibility in this important problem area is for research on the control, at the source, of pollutants produced as a result of the production, processing, handling, and utilization of the Nation's mineral and mineral fuels resources. Authority for conducting such research derives from the Bureau's organic act which states that scientific and technologic investigations shall be conducted on the extraction and utilization of mineral substances with a view to conserving resources through the prevention of waste, increasing safety, and on behalf of the Government to investigate mineral fuels.

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[1] Some hydrocarbons, for example methane, ethane, propane, n-butane and acetylene, are not considered sufficiently reactive to produce photochemical smog effects. The Department is working on methods which measure the reactive organic compounds in exhaust and will restate the hydrocarbon standard in terms of reactive hydrocarbons when methods and data satisfactory to the Department are developed.

At the present time, we are committed to research designed to provide feasible, economic methods for abatement of the ever-growing air pollution problems of this country. Although this research is being performed largely in cooperation with the Public Health Service, significant amounts of direct program funds of the Bureau are applied to research programs that originate as a result of efforts to conserve our natural resources. These programs also make a marked contribution towards the pollution abatement program. The two most active areas under investigation cover the control of fumes resulting from combustion of gasoline and diesel fuels in automotive engines and the control of sulfur oxides emissions from the combustion of fossil fuels.

The type of pollutants discharged from motor vehicles differs appreciably from those from industrial installations. Gasoline and diesel fuel are normally very low in sulfur. The exhaust gases are generally high in unburned and partially burned hydrocarbons, oxides of nitrogen, and carbon monoxide. Both automotive and diesel exhaust research is in progress in Bureau laboratories. This research stresses the relationship between types of fuel, combustion system characteristics, and the pollutants emitted. Work is also being done to identify and minimize those constituents of the exhaust that are most active in producing smog.

Just last month, engineers at our Bartlesville, Okla., Petroleum Research Center demonstrated the technical feasibility of equipping an automobile with control devices that will lower the concentration of pollutants emitted well below what the Commerce Department's Report of the Panel on Electrically Powered Vehicles considered as commercially feasible by 1970.

The demonstration involved equipping a 1967 stock model of popular make with devices called exhaust manifold reactors, which were developed by a domestic company interested in the problem of controlling automotive exhaust emissions. Use of the exhaust manifold reactors permits mixing additional air with the exhaust gases, thereby changing their chemical properties.

By applying these devices, the research group at Bartlesville has thus far been able to achieve these results:

(1) Emission of total hydrocarbons from the exhaust of the car has been reduced to less than 70 parts per million (ppm), compared with an average of 900 ppm in the exhausts from cars without pollution controls.

(2) The concentration of reactive hydrocarbons (those that form smog) has been reduced to less than 50 ppm. The Bureau believes that this concentration probably is less than 30 ppm, but further analytical studies are necessary to confirm this finding.

(3) Carbon monoxide has been reduced to less than 0.7 percent of the total exhaust mixture, compared with an estimated 3.5 percent for cars not equipped with pollution controls.

(4) Oxides of nitrogen have been reduced to 400 to 600 ppm, compared with concentrations that range from 1,000 to 2,000 ppm for conventional cars.

The following table compares the pollutant concentration recorded in extended tests of the Bureau's demonstration car with those considered commercially feasible by 1970.

	Bureau of Mines vehicle	Considered commercially feasible by 1970[1]	1970 California standards
Total hydrocarbons	70 p.p.m.	275 or 180 p.p.m.	180 p.p.m.
Carbon monoxide	0.7 percent	1.5 or 1 percent	1 percent.
Nitrogen oxides	400 to 600 p.p.m.	350 or 600 to 800 p.p.m.	350 p.p.m.

[1] Source: "The Automobile and Air Pollution." Report of the Panel on Electrically Powered Vehicles, U.S. Department of Commerce, October 1967.

It is particularly noteworthy that with its low hydrocarbon and carbon monoxide emissions the Bureau's demonstration car has exceeded both what is considered commercially feasible by 1970 and the standards proposed for California in that year. Only with respect to nitrogen-oxide levels have we missed the lowest mark established, and even there our work has refuted the pessimistic view that nitrogen oxides can be reduced below a certain level only if we are willing to accept higher levels of other contaminants.

Bureau of Mines responsibilities for the conservation and efficient utilization of fossil fuels places this agency in a unique position to take a responsible part in the overall Federal program on air pollution abatement. Therefore, our staff, in cooperation with the Public Health Service, is making every effort to find a feasible solution to the control of pollutants at the source of their production. We believe that a total systems approach to the problem is required if the problems of air pollution are to be solved without severe economic and social effects on the Nation as a whole.

Most air pollution ordinances that have been adopted or are being considered by cities, counties, states, etc., contain provisions limiting the sulfur content of fuels burned in stationary heating and power plants. This type of limitation is the only currently feasible method of effecting substantial and immediate reduction of emissions of sulfur oxides to the atmosphere.

Nevertheless, widespread adoption of such provisions would have a significant impact on the availability and cost of low-sulfur fuels. For example, over 90 percent of coal containing 1 percent or less sulfur is produced in the Appalachian area, which contains about 8 percent of total reserves of such coal. Furthermore, these low-sulfur coals are, (a) in great demand by metallurgical plants, both in the U.S. and in foreign countries, (b) priced substantially higher at the mine than high-sulfur coals, and (c) produced somewhat farther from the areas considering their use for air-pollution control purposes than are the higher-sulfur coals currently being used.

Accordingly, the Bureau recently embarked on a special cooperative project to determine the location, quality and availability of low-sulfur coals for energy production.

The combustion of fossil fuels in powerplants and for space heating is a principal source of air pollutants, particularly sulfur and nitrogen oxides. The Bureau of Mines is engaged in research that we believe will lead to practical and economically feasible methods for: (1) desulfurization of fuels and (2) the removal of sulfur oxides from stack gases before being released to the atmosphere and the subsequent recovery of the sulfur resulting from the combustion of these fuels, thus reducing the critical shortage of sulfur that now exists on a world-wide basis. It is estimated that more than 23 million tons of sulfur dioxide are discharged into the atmosphere annually from the combustion of fuels for heat and power purposes and from industrial operations such as the metallurgical processing of sulfide ores.

One of the most promising methods for the recovery of sulfur from stack gases is the alkalized alumina process, which the Bureau invented and then developed in conjunction with the U.S. Public Health Service.

The process consists of four steps:

1. *Absorption.*—Alkalized alumina is contacted by the flue gas to remove sulfur oxide.
2. *Regeneration.*—The alkalized alumina containing the sulfur oxide is treated with a reducing gas to convert the sulfated alumina to its original state for recycling in the process. Simultaneously, the sulfur oxide is converted to hydrogen sulfide.
3. *Production of reducing gas.*—A gas generator is required to supply the gas essential to step two above. The reducing gas may be derived from either coal or natural gas or heavy hydrocarbons.
4. *Sulfur production.*—Hydrogen sulfide is converted to elemental sulfur. Steps one and two are novel to the alkalized alumina process; steps three and four are borrowed from other existing commercial-scale operations.

Operated on the basis of 90 percent removal of sulfur oxide from stack gases obtained from the combustion of 3 percent sulfur coal, the process should produce one ton per day of byproduct sulfur for each 4.3 megawatts of power generated.

Research on the alkalized alumina process has proceeded through laboratory bench-scale experiments using simulated flue gases, to a small scale pilot plant study. This now has been followed by operations in an intermediate sized pilot plant capable of handling 55,000 cubic feet of stack gases per hour. Completely instrumented for automatic control, this latest unit is designed for operation over extended periods on a 7-day a week, 24-hour a day schedule.

On the basis of results obtained to date, the process appears promising, both technically and economically. Latest estimates, however, indicate that the system will not be ready for industrial application before late 1970 or early 1971 *at the present level of effort*. Normally, it would be recommended that any further development await the outcome of the present pilot plant research program. However, because of the urgency of the situation and since this process is the most promising, we believe steps should be initiated immediately to design and build a plant to desulfurize a gas stream equivalent to that from a 30 megawatt power plant. There has been sufficient indication of interest from industry that it may be possible to build such a plant as a cooperative venture between industry and Government.

Before concluding my statement, I would like to refer briefly to two additional problem areas of air pollution, which, although of comparatively limited scope, are nonetheless significant.

The first involves mine tailings. These are the materials rejected during the processing and concentration of minerals from ores. There are hundreds of millions of tons of such tailings throughout the country that are the frequent source of the air-borne material of dust storms. Locally, this type of pollution disposal can reach annoying proportions.

The Bureau is working on several techniques that can be broadly applied to the majority of problems of tailings piles. Many piles are composed of relatively barren material. In these piles, the originally desired mineral has been efficiently extracted and there are no accompanying minerals worth removing. For these tailings, the only solution is disposal in an unobjectionable manner and we are investigating two methods of doing this. One involves chemical treatment for temporary stabilization, followed by fertilization and seeding with selected seeds to provide a permanent cover of vegetation that will minimize or prevent wind and rain erosion and the accompanying air and water pollution. The scenic blight caused by barren tailings dumps is also minimized by this procedure. The other approach involves injection of slurried tailings into underground strata. This technique has been shown to be technically feasible even for relatively coarse material, and the economics are now under investigation.

The other problem area that has been generally recognized for some time involves the pollution of the atmosphere within underground mines. In recent years the Bureau has attacked the control of airborne quartz that, when inhaled in excessive quantities· causes silicosis, and has undertaken an extensive survey of dustiness levels in bituminous coal mines where a chest disease known as coal miners' pneumoconiosis is found as part of a joint program with the Public Health Service. More recently in response to the growing concern with respect to the occurrences of lung cancer among uranium miners, we have surveyed 175 mines to evaluate the level of alpha radiation from radon daughters to which the men have been exposed and made recommendations for ventilation improvement, wherever we could, to reduce their exposure. Seventy-five of the mines were subsequently resurveyed. In those mines, the proportion of the men receiving less than 1.0 Working Level Day of exposure increased from 38.4% to 65% in the interim. One Working Level Day corresponds to the present requirement promulgated by the Department of Labor under the Walsh-Healey Act.

In conclusion, I would like to stress that the problems of environmental pollution, including pollution of the atmosphere, are, to a large degree, a byproduct of our economic progress, as well as past neglect and apathy. And these problems can be expected to increase in importance as our technology and standard of living continue to grow. It is unfortunate indeed, that our scientific knowledge of the causes and character of environmental pollution is more extensive than the technology to handle the waste products of our industrial civilization. Nevertheless, we believe that through continued research and engineering development, it will be possible to solve the problems confronting the Nation effectively and economically. The Bureau of Mines recognizes its responsibilities for the control of pollutants produced as a result of the production, processing, handling, and utilization of the Nation's mineral and mineral fuels resources and will continue to work for technically and economically feasible solutions to the problems arising therefrom.

Thank you for the opportunity to appear before you today, Mr. Chairman. I am at your service to answer any questions that may have occurred to you or the committee members.

ADDITIONAL STATEMENT BY DR. BLOMQUIST

In the testimony cited by Mr. Daddario, Dr. Bennett said: "The problem is not that we lack evidence that some of these pollutants do affect health. We are lacking evidence that they actually cause disease. There is abundant evidence that an individual suffering from chronic disease has aggravated symptoms. There is abundant evidence that they cut down on performance of otherwise healthy individuals when they exert themselves. There is abundant evidence that they are harmful to plants. On the other hand, the area in which we are almost totally lacking in knowledge is what the effect will be of exposure to relatively low concentrations of materials over a period of 10, 20, or 30 years."

Dr. Bennett said, in short, that air pollution is indeed known to be a health hazard, and that what remains to be determined is exactly how serious a hazard it is. I am basically in accord with this view, though I do not agree in detail with everything Dr. Bennett said. I believe he and I are very concerned with determining at what level of a given pollutant or combination of pollutants injurious effects begin to take place, effects which culminate in increased morbidity and mortality years later.

In my opinion, it is overly conservative to say that we are "almost totally lacking" in knowledge of the effects of long-term exposure to relatively low levels of pollution in the air. There is already a substantial fund of scientific knowledge which indicates, without doubt, that long-term exposure to ordinary levels of air pollution in urban communities is associated with the worsening and, quite possibly, even with the initiation of chronic respiratory diseases such as asthma, bronchitis, and emphysema.

I submit that much of the speculation and controversy about whether or not air pollution causes disease is irrelevant to the significance of air pollution as a public health hazard. We are accustomed to thinking that a disease state is brought about by a single cause—a carryover from a period in public health history when virtually total emphasis was placed on *the* bacterial or viral agent which had to be identified before a communicable disease could be recognized and dealt with. That there is frequently a simple association between an infectious disease agent and the acute disease reaction which it provokes is an observation that has been and still is important in public health work. But we have learned that it is not the master key that unlocks all the secrets of disease and health. The idea that one factor is wholly responsible for any one illness is patently too simple to provide all the answers we need to deal with the chronic diseases which are a growing problem today.

Chronic bronchitis is a good example. It develops over a long period of time and can become crippling through a combination of many factors—air pollution, smoking, repeated and recurring bouts with infectious agents, occupational exposures—all affected, perhaps, by an hereditary predisposition. What then is *the* cause of chronic bronchitis? The answer is obvious. There is probably no single cause, but there is sufficient evidence that air pollution can and does contribute to its development. This is what really matters, whether we choose to consider it *the* cause, one of several causes, or simply a contributing factor.

Mr. DADDARIO. This committee tomorrow will hear from Dr. Robert Ekhart, who will be representing the American Petroleum Institute, and Dr. Harold MacFarland of Hazleton Laboratories.

We shall adjourn until tomorrow morning at 10 o'clock at this same place.

(Whereupon, at 12:45 p.m., the committee adjourned, to reconvene at 10 a.m., Friday, January 19, 1968.)

ENVIRONMENTAL QUALITY

FRIDAY, JANUARY 19, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order. Today we continue our inquiry into the status of scientific knowledge and research management in support of our national goals for environmental quality, achieving and maintaining satisfactory air quality impacts most forcefully on our energy industries, electrical power generation, space heating, industrial processing, and transportation burned fossil fuel with the oxygen of the air and thereby encounter the problems of returning that air to the community atmosphere without degrading its quality. The air we breathe is the same air which flows through furnaces and engines. How can we continue to keep these two uses compatible one with the other?

Our witnesses today represent the oil and coal industries as medical and environmental health experts. The adversary nature of their position vis-a-vis the Public Health Service officials is a valuable mechanism which should help achieve the optimum cost benefit relationship in pollution control.

This subcommittee believes it necessary to secure diverse information sources and advice in complex matters of science policy. Therefore, we welcome the testimony today as a further contribution on the criterial establishment problem. The Air Quality Act of 1967 provides for appropriate advisory committees to the Secretary of Health, Education, and Welfare, which shall include medical and scientific personnel and industrial experts.

The clear intent of the Congress is that air quality criteria shall reflect an honest appraisal of all available facts.

I repeat, therefore, my concern is that the new law cannot function unless criteria are agreed upon which can be practically implemented.

The responsibility for environmental science to achieve this is planned. Dr. Robert Eckardt is representing the American Petroleum Institute. He is accompanied by Mr. Gammelgard. We appreciate the help they have given this subcommittee in the past, and today they are also joined by Dr. Harold MacFarland of the Hazelton Laboratories.

Gentleman, we are pleased you are here with us today and appreciate your coming and are anxious to hear what you have to say.

Dr. Eckardt, if you would proceed, please.

(Dr. Eckardt's biography follows:)

ROBERT E. ECKARDT, MD

Age.—Born May 1, 1916.

Secondary School.—Great Neck High School, Great Neck, N.Y.

College.—Antioch College—Yellow Springs, Ohio: B.S. with honors in chemistry—1937.

Graduate School.—Western Reserve University—Cleveland, Ohio: M.S. in biochemistry—1939—Thesis—"Nutritional Cataract with Special Reference to Galactose Cataracts in Rats," Ph. D. in biochemistry—1940—Thesis—"Vascularization of the Cornea in Riboflavin Deficiency."

Medical School.—Western Reserve University—Cleveland, Ohio: M.D.—February, 1943.

Internship.—Straight medicine—New York Hospital: March 1943–January 1944.

Residency.—Straight medicine—New York Hospital: January 1944–October 1944 and June 1947–July 1948.

Hospital Appointments.—Assistant Attending Physician in Medicine, OPD—New York Hospital: 1948 to 1967. Attending Physician to Outpatients: 1967 to Present. Associate Attending in Medicine—University Medical Center—University Hospital: Sept. 1, 1962 to Present.

Medical School Appointments.—Instructor in Medicine—Cornell: 1948–1967. Clinical Assistant Professor of Medicine—Cornell: 1967 to Present. Assistant Clinical Professor of Industrial Medicine—NYU—Postgraduate Medical School: 1952–1967. Associate Clinical Professor of Environmental Medicine—NYU: 1967.

Licenses.—Diplomate—National Board of Medical Examiners New York State—by reciprocity with National Board: 1947. New Jersey—by reciprocity with National Board: 1951.

Specialty Certification.—Diplomate—American Board of Internal Medicine: 1950. Diplomate—American Board of Preventive Medicine (Occ. Med.): 1955. Appointed to the Executive Board: 1967.

Membership in Professional Societies.—American College of Physicians: Associate: 1950–1954; Fellow: 1954.

American Medical Association: Committee on Occupational Toxicology: Member, 1965; Chairman, 1968.

Union County and New Jersey State Medical Society.

Industrial Medical Association: Director, 1954–1956; President, 1960–1961.

American Industrial Hygiene Association: Director, 1953–1955.

Fellow, N.Y. Academy of Medicine: Sec'y, Occ. Health Section, 1967–1968; Member, Education Committee, 1968.

Fellow, American Academy of Occupational Medicine.

Member, New York Academy of Sciences, 1951.

Member, The Scientific Research Society of America, 1952.

Permanent Commission and International Association on Occupational Health: Secretary-General: XIIIth International Congress, N.Y., 1960; Elected a Member of the U.S. Delegation, 1960; Membership Committee, 1963 to Present; Chairman, U.S. Members, 1967 to Present.

American Public Health Association.

Air Pollution Control Association.

Membership in Associations.—American Petroleum Institute.

STATEMENT OF R. E. ECKARDT, M.D., DIRECTOR OF THE MEDICAL RESEARCH DIVISION OF ESSO RESEARCH & ENGINEERING CO., LINDEN, N.J.; ACCOMPANIED BY P. N. GAMMELGARD, VICE PRESIDENT, CONSERVATION AND MANUFACTURING, AMERICAN PETROLEUM INSTITUTE

Dr. ECKARDT. Thank you, Mr. Chairman.

On behalf of the institute and its member companies, I should like to thank the committee for this opportunity to present our industry's views concerning the problems that may be encountered in implementing the newly passed Air Quality Act of 1967. We believe your committee is acting most appropriately in trying to ascertain what those problems are likely to be.

In the Air Quality Act, Congress wisely recognized the need to take economic and technologic factors into account in the setting of air quality standards. Thus it provided for consultation between the Secretary of HEW and appropriate technical advisory committees in establishing air quality criteria for use as guidelines by the States in setting standards.

We believe that standards that go beyond protection of public health ought properly to be based on a realistic assessment of the technologic feasibility and economic effects of compliance. In other words, the benefits of more stringent control than that needed to protect health should be commensurate with its cost.

Mr. DADDARIO. Dr. Eckardt, when you say it should be commensurate with its cost, do you mean that, or do you mean that establishing a criteria so that there can be a judgment as to what it will cost, recognizing health and aesthetics and everything else. Then the public can come to a decision what it is willing to pay rather than to assume that somebody in a committee will arbitrarily come to that judgment.

Dr. ECKARDT. That is right.

I would say this is precisely what we mean, that good cost figures should be available.

Because our industry possesses considerable expertise in air quality matters, we look forward to making a meaningful contribution to the scientific deliberations that must precede establishment of air quality criteria and standards.

To better enable our industry spokesmen to participate impartially and effectively in these deliberations, the American Petroleum Institute has arranged for a number of eminent medical and scientific experts to review all previous experimental work pertinent to the establishment of air quality criteria. We have also asked that they give us their independent views as to what might be considered reasonable air quality standards under various conditions—standards that would provide for the protection of health.

Mr. DADDARIO. Could you explain a little bit about how that works? When did they start, how many people are involved?

Dr. ECKARDT. This started about 3 or 4 months ago. The concept arose within our industry. We are collecting together, I would estimate, approximately 20 people. Presumably each individual would be an expert in an area of air pollution. Perhaps in relationship to one or another of the pollutants involved.

Mr. DADDARIO. How many people are you talking about?

Dr. ECKARDT. About 20.

Mr. DADDARIO. Are they doing this on a consultant basis?

Dr. ECKARDT. On a consultant basis, yes, sir.

Mr. DADDARIO. How much money and time is involved, or is this something you will work out as you go along?

Dr. ECKARDT. This is entirely their decision to make. We contacted the experts and asked them what they thought it would take to do the job that we were asking in terms of time and money.

Mr. DADDARIO. You are in the process of working it out. Do you have any idea as to when you might expect to get some results?

Dr. ECKARDT. We are hoping to get some early this spring.

Mr. DADDARIO. Mr. Bell.

Mr. BELL. Dr. Eckardt, in areas like Los Angeles County they have requirements to alleviate the pollutants that may come out of your refineries. Could you tell me what that is and how much it costs?

Dr. ECKARDT. I presume Mr. Gammelgard can answer this better.

Mr. GAMMELGARD. The industry in the Los Angeles Basin has taken a great number of measures, such as floating roof tanks to prevent evaporation loss from tanks. This raises the cost of the tank by at least 50 percent over what it would cost for a conventional cone roof tank.

Mr. BELL. Is that the tank that prevents the evaporation of the liquid gasoline?

Mr. GAMMELGARD. Yes. The roof floats on the surface of the liquid. Electrostatic precipitators on catalytic cracking units catch the last bit of catalyst dust that would otherwise get into the atmosphere. There are covered oil and water separators, closed loading systems on the tank truck and tank car racks to prevent vapors going into the atmosphere. Smokeless flares are used, as are sulfur recovery units.

These are very expensive measures and Los Angeles is certainly one area of the country where they do have a key problem and where much money has been spent.

Mr. BELL. How much are you talking about in money for one refinery that would be in one of the major industries?

Mr. GAMMELGARD. I would guess in the Los Angeles area they have invested $75 million to $100 million in facilities to control pollution from the refineries in the Los Angeles Basin. (Figures checked later and found to be $87 million capital investment and $100 million operating and maintenance costs for the period 1948–1965 inclusive.)

Mr. BELL. That is the total figure for all the refineries.

Mr. GAMMELGARD. In the Los Angeles Basin only.

Mr. BELL. Are you talking about major oil refineries or independents, too?

Mr. GAMMELGARD. All of them.

Mr. DADDARIO. Do you have any estimate as to what you save by preventing the evaporation? It seems to me it serves that purpose as well.

Mr. GAMMELGARD. There are some savings in the use of floating roof tanks for the lighter products like gasoline, but it is not exactly the type of investment you like to make because the payoff is pretty long.

Mr. DADDARIO. But there is some writeoff.

Mr. GAMMELGARD. Yes, there is.

Mr. BELL. When you have shutdowns for cleanup and repairs of the refineries and you are getting the coat off the tanks and conning towers, there is no falloff from that, is there?

Mr. GAMMELGARD. No.

Mr. DADDARIO. Mr. Mosher.

Mr. MOSHER. Dr. Eckardt, so far in your testimony you seem to be making a distinction between those standards that would provide for the protection of health and those that go beyond the protection of public health. Do you want to give us a suggestion of what the potential standards are that might be required that go beyond the protection of health? What are you thinking of there?

Dr. ECKARDT. I am thinking of material damage, plant damage, agricultural damage, corrosion of buildings, reduced visibility, all of the nonhealth factors that may be associated with air pollution.

Mr. MOSHER. I thought it would be helpful for clarification. You are making that distinction so far very definitely?

Dr. ECKARDT. Yes.

Mr. DADDARIO. Will you proceed, please?

Dr. ECKARDT. In addition, in June of this year, the institute will join with the Air Pollution Control Association, the American Industrial Hygiene Association, and the Industrial Medical Association in cosponsorship of a symposium on air quality criteria.

Parenthetically, I might add here that the National Center on Air Pollution Control has been invited to participate in this symposium to any extent that they desire.

This symposium will be held in New York City. Its purpose will be to provide an opportunity for medical and environmental scientists, from both the public and private sectors, to review the present state of knowledge concerning the effects of air pollution—and to air their views concerning what would constitute reasonable air quality criteria in the light of present knowledge.

As this committee undoubtedly knows, air quality criteria are not themselves prescriptions for air quality. They are scientific judgments, based as far as possible on available data.

Ideally, such data would convincingly relate specific time concentrations of pollutants, or combinations of pollutants, to specific effects on man and his environment.

In practice, however, this may not be so simple because the toxicologist has learned that curves relating time-dose to effect are not linear. This is because the effects at high concentrations and short exposure times often differ qualitatively from the effects produced by low concentrations over prolonged exposure.

Moreover, very few efforts have ever been made to develop appropriate data relating long-range, low-dose exposure to air pollutants with specific effects on health. Thus, any criteria issued at this time with regard to such long-term, low-dose effects must necessarily be regarded as speculative and should be so labeled.

An excellent illustration of this is the fact that during the past year no fewer than three separate sets of criteria for sulfur oxides have been issued—one by the U.S. Public Health Service, one by the State of Pennsylvania, and one from Holland. The figures arrived at by each group were different, even though many of the same source data were used and the approach and concern were presumably quite similar.

Mr. DADDARIO. Dr. Eckardt, how do they differ? Are they more or less stringent? Why do you call these three to our attention beyond the fact that there were three sets of criteria developed in this way?

What is so important about it?

Dr. ECKARDT. The importance of this is the level at which effects are attributed. In the air quality criteria by the PHS basically they are talking about a tenth of a part per million for SO_2 on a 24-hour basis. The State of Pennsylvania proposes 0.25 parts per million on a 24-hour basis. The report from Holland, as I remember the figure, is three-tenths part per million on an 8-hour basis. These levels are those to which they feel we are going to have to control air pollution and they differ. This obviously means that the control that you have to put in will differ in order to get a specific level.

Mr. DADDARIO. Are your objectives determined through these experts you are bringing together, or is one of your objectives to see if there can be a reconciliation between these various levels of criteria?

Dr. ECKARDT. Yes, sir.

Mr. DADDARIO. Are you suggesting because of the high concentration and the short period of time which brings about some of these dangerous episodes that it is a special kind of problem and has to be looked at in a different way than the long-term, low-concentration problems?

Dr. ECKARDT. I think this is true. To me the most pressing problem is the acute episode I think we have the ability to control it today. The long-term one we are not so sure about.

Mr. DADDARIO. That is encouraging. You believe that the episodes can be controlled. Is this because of advanced meteorological capabilities?

Dr. ECKARDT. Yes, sir.

Mr. DADDARIO. Will you go into that a bit as to why you are optimistic?

Dr. ECKARDT. Yes. I think the reason they can be controlled are two in nature: One, we have more advanced meteorological data and two, we have more advanced knowledge of what the levels are in various cities, which we have not had before. As an example, New York City up until the time that Austin Heller came there as air pollution commissioner basically was measuring its SO_2 levels at one station. Now they are measuring out of ten telemetered stations which print out the results in a central office where somebody can keep good track of them. They know much more rapidly what is going on in New York today than they ever did before. The same thing is going on in Chicago where they have eight telemetered stations, and the data can be looked at at 15-minute intervals, if you wish, because the sampling keeps repeating itself every 15 minutes.

Mr. DADDARIO. How does the medical man who is an expert on the effects of these pollutants in such concentrations come to a judgment how the weather conditions, in fact, change that situation, either for better or worse?

What capability does he have as a medical man to feed into this the judgments necessary so that we have some assurance that he is right, these disciplines being so different one from the other.

Dr. ECKARDT. Unfortunately at the present time this has not been developed to accompany concurrently the analytical data being telemetered into the stations. I happen to serve on the medical advisory committee in New York, and one of the things that we are considering now is a mechanism by which we can feed the medical data into the central station the same way we are now feeding in analytical data.

Mr. DADDARIO. Will you tell us a little bit about that? What does it involve?

Dr. ECKARDT. I cannot tell you this right now because the plans have not yet been worked out. I do not know what will utimately develop. But presumably it will consist of a system whereby admissions to hospitals, admissions to emergency rooms in hospitals in the city, hopefully perhaps reports from private physicians who see people that they think are affected by air pollution will be sent into a central location where this data can be collated with the air pollution analytical data.

Unfortunately, up until now we have had to go back and analyze what happened in retrospect during an episode. For instance, after the famous November 1966 episode that Mr. Ryan talked about yesterday, the report on the health effects of that only appeared in the December 1967 Archives of Environmental Health. It took them 1 year to analyze the health effects data.

Mr. DADDARIO. What you are doing is establishing a whole series of denominators which will begin to develop an understanding on both sides. Both the weather people and the medical people will be able to put these together in a meaningful way.

Dr. ECKARDT. We hope so.

Mr. DADDARIO. Mr. Bell.

Mr. BELL. Dr. Eckardt, you say on page 4, "Thus any criteria issued at this time with regard to such long-term, low-dose effects * * * must be regarded as speculative."

How long would it take you to develop such criteria? Do you have have any length of time figured on that?

Dr. ECKARDT. I am not sure that we will ever have complete data to be any more than speculative about this. I think we are going to have to feed one element in and attempt to develop air quality criteria and that is judgment. I do not know how you define it. Maybe judgment is not speculative, but it is not a hard-and-fast number analysis. You are going to have to feed into this very competent medical judgment which is going to have to take into account judgments which probably cannot be fed into a computer.

Mr. BELL. What is the time period on that?

Dr. ECKARDT. You mean how long will it be before criteria are developed?

Mr. BELL. Yes.

Dr. ECKARDT. I would think they can be developed in accordance with the timetable that Dr. Middleton talked about yesterday. He proposed that perhaps by the end of this fiscal year they would have three air quality criteria issued.

Mr. BELL. I see.

Dr. ECKARDT. I have talked with them and I know they plan two additional ones, probably by the end of 1968.

Mr. DADDARIO. Dr. Eckardt, these three reports you are talking about, the Public Health Service has 0.1 part per million, State of Pennsylvania, 0.25, Holland 0.3. What does this really mean? As you look at it, what does it mean in the difference in abatement cost to meet each of these proposed criteria? What does it show us if we are to look at one as against the other?

Dr. ECKARDT. I will attempt to answer that. I do not know whether I can do it adequately.

Mr. DADDARIO. Why don't you give us an explanation and then we can go over it and refine it for the record later if you wish.

Dr. ECKARDT. Yes. A few years ago the Public Health Service issued some suggestions as to how Federal installations in the cities of New York, Philadelphia, and Chicago should try to meet their responsibilities in air pollution control. The proposition was that New York City would need 0.3-percent sulfur fuel. Philadelphia would need 0.6-percent sulfur fuel, and Chicago, 0.6-percent sulfur fuel. Previously, New York had proposed that they wanted to go to a 1-percent sulfur fuel. I am not a refining expert and perhaps if I make a mistake here Mr. Gammelgard can correct me, but my understanding is that to go from 1-percent sulfur fuel to 0.3-percent sulfur fuel in a single refinery might represent an increase in capital investment in refining equipment of the order of $50 to $100 million; the total investment running between $150 and $200 million, with an additional $50 or $100 million if you have to go from 1 percent to 0.3. Would this be a fair figure?

Mr. GAMMELGARD. In that ball park; yes. We are talking about desulfurizing heavy black fuel. The cost of desulfurizing home heating oils Nos. 1 and 2 is much lower. But the heavy black fuel is harder to desulfurize. It has more sulfur in it by far than the lighter fuels to begin with and it takes a lot more hydrogen and a lot more severe processing to get the sulfur out. If you start with two and a half or three and a half percent sulfur and you go down to 1 percent, one set of economics applies. If you want to get down to three-tenths of 1 percent, it really adds to the cost. I would say it probably would double the cost to go down to 0.3-percent sulfur.

Do I make myself clear? We are probably talking over a dollar a barrel in added cost to get down to three-tenths of a percent sulfur.

Mr. DADDARIO. Carry that a bit further so that we get it down to terms we understand. A dollar a barrel. How does that affect heating costs in the ordinary home? Can you bring it down that far?*

Mr. GAMMELGARD. Residual fuel would not be used in the ordinary home.

Mr. DADDARIO. Let us say a factory or apartment building.

Mr. GAMMELGARD. This would be big apartment buildings and public buildings. In the New York harbor barge market, the 2.2-percent sulfur residual fuel currently being sold there is probably selling for around $2.25 per barrel. If the customer would have to pay another dollar a barrel to get down to 0.3 percent or if he has to pay 50 cents more per barrel to get down to 1 percent, the effect on heating costs would be in a direct ratio from the current level of around $2.25 to either $2.75 or to $3.25, as the case might be. These economies, as I have said, do not hold for home heating oils because they can be desulfurized much more easily and at a much lower cost.

Mr. BELL. What effect would this have on your industry as compared with a competitor such as gas? Would it drive your type of fuel oil out of business as far as competing adequately with gas as a source of heat?

Mr. GAMMELGARD. It could well do that if you are talking about residual fuel made from domestically produced crude. The same economics do not hold for foreign-produced crude. The economics change. If you are talking residual fuel from domestic crude in a midwestern refinery, you might price yourself right out of competition with either gas or coal.

If you cannot sell the residual fuel oil due to sulfur specification problems, you could then hydrocrack this fuel into lighter products—which would probably be the route a lot of domestic refiners operating on domestic crude would take.

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*See Appendix B, page 555, for additional information obtained from Consolidated Edison Company of New York, Inc.

Mr. **Bell**. You also sell a great deal of the heavy fuel oil to vessels, don't you, ships and trucks and trains and so forth.

Mr. **Gammelgard**. Yes, though trains are pretty much out of that market. They are practically all diesels now; vessels, yes.

Vessels out in the ocean are not an air pollution problem and they can burn high-sulfur residual, and may do that. They have a problem when they get into a port like New York where they have to burn a low-sulfur fuel while in port.

Dr. **Eckardt**. I think one of the things we have said here applies strictly to the petroleum industry. What the costs of controlling sulfur for the coal industry are I am not in a position to say, and I am not sure that anybody is because it seems at the moment the only way you are going to do this is to desulfurize the stack gases. I am not sure we have any valid estimates of how much this would cost at the present time.

Mr. **Bell**. In many areas you are not allowed to stack gases, isn't that true?

Dr. **Eckardt**. I beg your pardon?

Mr. **Bell**. Are you still allowed to stack gases?

Dr. **Eckardt**. Yes.

Mr. **Bell**. I thought there was some restriction on that.

Mr. **Gammelgard**. Mr. Bell in some areas you are not permitted unrestricted sulfur oxides coming out of a stack. Some of the regulations are written in such a manner as to say you must burn a half percent maximum sulfur fuel or you may alternatively desulfurize the stack gases to the same amount of sulfur dioxide coming out the stack as you would have to put out by burning a half percent sulfur fuel. There are two ways to go.

Mr. **Daddario**. Continue, please, Dr. Eckardt.

Dr. **Eckardt**. Nevertheless, we do feel strongly that the public interest will best be served if it is recognized that such judgments are based on scant or inconclusive evidence. As new evidence is developed, a reassessment, and possibly new judgments, will have to be made.

Once a judgment has been reached, however, it should be possible to determine what course of action will best serve the public interest in a given situation. It must be recognized, however, that the public interest may not be served well if we fail to give proper weight to economic and technologic factors.

For example, recently reported studies of the population residing in the Nashville, Tenn., area reveal a very close correlation between socioeconomic status and health, whereas the correlation between relative exposure to air pollution and health in the same population sample was far less consistent. This is not to say that air pollution may not be health related, but socioeconomic status unquestionably plays a more significant role in public health than does air pollution.

For the reasons I have just given, we would favor a procedure—regardless whether it is applied at the regional, State, or local level—whereby proposed standards be published far enough in advance of final hearing and adoption to permit affected parties to determine what their control requirements and cost of compliance will be. This would permit an assessment of benefits versus costs at final public hearing before adoption of standards and rigid timetables for compliance.

Such a policy would also serve to eliminate much of the apprehension affected parties might feel if confronted with regulatory proposals whose economic consequences they did not have time to assess. Moreover, it would give them the time to determine how much leadtime would be required and whether compliance is, in fact, possible.

For example, a study was recently made for the American Petroleum Institute by the Bechtel Corp. to determine the cost of equipping refineries in the Caribbean area to produce extremely low sulfur content fuel oil for their eastern seaboard markets. The study showed that the required investment in new refining facilities would total more than three quarters of a billion dollars.

Obviously, the leadtime required to complete such a huge capital investment program is significant and should not be ignored in setting deadlines for delivery of extremely low sulfur content fuels.

Mr. DADDARIO. How much time are you talking about? The present law is 15 months after the criteria has been established. Do you disagree with that figure?

Dr. ECKARDT. I would say to design—from the time you reached the decision to put in desulfurization facilities, put it on the design board, go ahead and construct it and get it into operation would be of the order of 3 to 4 years.

Maybe Mr. Gammelgard would disagree with this.

Mr. GAMMELGARD. I would lower it and say 2 to 4 years.

Mr. DADDARIO. Shouldn't we assume that during the period of time when this criteria is being established that you are somehow keeping pace with it? I don't understand, Dr. Eckardt, that the criteria could come to you as a complete surprise. Somewhere along the line, with all these mechanisms you are presently developing—the fact that you are keeping in touch with the regulatory agencies—your activities must be taking place, simultaneously and in lockstep, with the development of the criteria I would think.

Dr. ECKARDT. I have learned this from talking with some of my technical people: The problem is that targets have been moving. In New York they had a time schedule for reduction of sulfur content of fuel. They started at 2.5 percent and now they are supposedly at 2.2 and they ultimately in the 1970's will get to 1 percent.

We then had an abatement conference in the New York area where they proposed that fuel content go to three-tenths of a percent by 1969, I believe, were the recommendations. Now, this makes it very difficult to keep up with. We were trying to keep pace with the previous schedule and now a new one comes in and you can't keep up with it. We couldn't possibly meet the 1969 recommendation of three-tenths percent sulfur through desulfurization facilities.

Mr. DADDARIO. What is it that prevents you from keeping up? As the targets move—as we could expect them to, as the people desire higher standards—what does cause you problems? Is there a liaison problem here, so that you aren't in fact able to establish a relationship with those people who are establishing criteria? Or is it that they, not being professionally competent, are establishing a criteria beyond their ability or your ability to achieve? You know about it, but there is nothing presently available from a technical point of view so that you could adhere to it whether you wanted to or not? Where does the problem come from?

Dr. ECKARDT. I think the problem comes in that we don't know where the level is going to be set. I think the example is evidenced by the fact that three different people came up with three different criteria.

Mr. DADDARIO. By "level" do you mean there is no level which can be set which you now are capable of meeting?

Dr. ECKARDT. There is some level, yes.

Mr. DADDARIO. Is this part of the problem?

Dr. ECKARDT. I think this is right, yes.

We had a conference with the Public Health Service prior to the issuance of these (indicating) and we proposed that rather than come out with these recommended levels at this time that perhaps we come out with an intermediary level until such time as the leadtime to produce what they felt really was necessary would be obtained.

Mr. DADDARIO. Are you able to discuss why this recommendation was not followed?

Dr. ECKARDT. I don't understand that. I don't know why, frankly.

Mr. DADDARIO. But your request for an intermediary standard was so that you could develop the technical capability in order to put your shop in order and to meet that particular criteria. Once achieved, you could then begin looking for higher goals.

Mr. GAMMELGARD. That was part of it, I might add, Mr. Chairman. The other part was that with inadequate monitoring in New York City they didn't know what was in the atmosphere in New York City as a whole—just a couple of points. By bringing the sulfur down from around 2.5 percent in the residual fuel oils used in the powerplants and other big buildings, down to some intermediate level, then establishing a good monitoring system, which Austin Heller is now doing—you might find by going to 1 percent you would achieve a satisfactory level of sulfur dioxide in the atmosphere. To require going from 2.5 down to three-tenths in a couple of years could result in sulfur dioxide levels lower than the one-tenth part per million recommended by PHS.

Mr. DADDARIO. Then your problem involves the techniques necessary to know what ought to be done, and then the ability to have the time within which you could acceptably and technically meet those requirements.

Mr. GAMMELGARD. Exactly.

Mr. MOSHER. In the book supplied by U.S. Public Health Service, what are the time requirements with regard to the one-tenth part per million?

Dr. ECKARDT. This is not a regulation, but a criteria. We are concerned about the mechanism by which criteria would be adopted into standards which would then come under regulations.

Mr. MOSHER. You are not under any specific time compulsion?

Dr. ECKARDT. Under this document, no, but in Pennsylvania, yes.

Mr. BELL. Dr. Eckardt, you said the Bechtel Corp. was doing a study in which the cost of equipping the refineries in the Caribbean areas to produce low sulfur content oils would cost in the area of three-quarters of a billion dollars. What was the level you were trying to reach in that study?

Mr. GAMMELGARD. That was getting down to a level of approximately a half percent. Hopefully maybe a little lower than that.

Mr. BELL. Actually that may not even be a requirement as far as the eastern seaboard is concerned? You may be getting 2 percent or 1 percent?

Mr. GAMMELGARD. With the rules that are currently under study in New York and New Jersey, it looks like the three-tenths, and the .37 they are talking about, is more realistic as to what their goal is than 1 percent.

Mr. DADDARIO. Mr. Gammelgard, when will New York City have what you would expect to be a good monitoring system? They are developing it at the moment, as I understand it, but when will they achieve it?

Mr. GAMMELGARD. I believe that they expect to have it by the end of this year. I think his goal is 36 stations with a grid covering the five boroughs.

Mr. DADDARIO. Taking New York as one area, where do we stand in our other cities?

Mr. GAMMELGARD. Chicago has an excellent system which went in about 4 years ago in which they girded the entire city and then telemetered in from some of the key stations—not all of them, because telemetering is expensive. They know what the air in Chicago contains. There are eight telemetered stations measuring wind velocity and direction plus SO_2 and they soon will add devices to measure particulates.

I am quite certain Los Angeles has a good grasp on what is in their atmosphere. I don't know what their monitoring system is, but very few cities have a sufficient number of stations to really know what is in their atmosphere.

The Government CAMP system, or continuous air monitoring program, usually consists of one station per city, and this is not a good indication of what is in the atmosphere of a big city.

Mr. DADDARIO. Are the techniques which are being developed to set up these stations, even though the weather conditions are different in certain places, are they systems mutually compatible so that the lessons being learned in those cities where we are doing a good job, such as Chicago, can be transferred quickly and without too much cost to these other cities?

Mr. GAMMELGARD. Yes.

Mr. DADDARIO. Do you have any idea as to what the size of the city ought to be to necessarily compel it to have a good monitoring system?

Mr. GAMMELGARD. I think it would probably depend on what the air pollution problem seems to be in the city. Certainly some cities have a much lesser problem, obviously, than others.

Mr. DADDARIO. But it would be wise for most cities of size to take a look at this and to come to some judgment about what they do need.

Mr. GAMMELGARD. I think so, like your Clevelands, Toledos and Detroits. They certainly should have their air system adequately monitored.

Mr. DADDARIO. Which they presently do not have?

Mr. GAMMELGARD. They don't in my opinion.

Mr. MOSHER. You say there is a need for more than one monitoring location in each city?

Mr. GAMMELGARD. Yes.

Mr. MOSHER. Can you put this in terms of square miles or number of population? How about a city of 80,000, would one monitoring spot be all right for small cities such as that, or does this depend on what the industrial situation is there, and the location of the industries? Is that what determines it?

Mr. GAMMELGARD. Not only industry, but other sources, too.

I would say, for example, Tulsa is one of the cleanest cities in the country and I think if they had one well-located station they couldn't justify putting in a dozen stations or even a half dozen.

Mr. MOSHER. So this is an individual decision depending on the character of the city?

Mr. GAMMELGARD. Yes. As I recall the Chicago system, just the monitoring stations, the equipment itself costs something like $135,000, so you are not talking about peanuts for a good system.

Mr. DADDARIO. What responsibility do you have, taking into consideration that we are in the process of establishing criteria to improve things, to anticipate what some Government agency may require you to do by taking the situation as it presently exists, and doing what is necessary to improve it, without any compulsion?

Dr. ECKARDT. We are attempting to anticipate this and proceed accordingly.

Mr. DADDARIO. We could expect, then, that industry will be making such efforts?

Dr. ECKARDT. I think they will, yes.

Mr. GAMMELGARD. I'd like to point out, Mr. Chairman, that since the end of World War II, all of our lighter products, gasoline, kerosene, No. 1 and No. 2 heating oils and diesel fuels, have all been desulfurized to a much greater degree than they were at the end of World War II so that the sulfur content has dropped by more than 50 percent in that 20-year period in the light products. There is practically no sulfur in gasoline today, but desulfurizing heavy residual fuel, which is our remaining problem, is very expensive and as the point was made, you can price yourself out of the market if your competing fuels still stay at the present level.

Mr. DADDARIO. You finally answered Mr. Bell's question.

You would expect, then, that the same research which has allowed you to do a better job with certain fuels will continue to go on, I would expect, at an accelerated pace, to the point where you can do the same thing with these other fuels that presently cause you this problem?

Mr. GAMMELGARD. Yes.

Mr. DADDARIO. It is not that you are ignoring the situation. You recognize that it exists and you are trying to do something about it.

Mr. GAMMELGARD. In the year 1966 the oil companies in this country spent over $4 million on research to develop or to improve the desulfurization processes for residual fuel.

Mr. DADDARIO. Do you have any judgment, Mr. Gammelgard, as to what research effort is going to be required in order to do a much better job in this area? As you look at it, do you have an estimate as to what time period will allow you to improve this sulfur content?

Mr. GAMMELGARD. We have the technical feasibility now to desulfurize residual fuel oils. One of the major companies operating in this country and in South America made an investment several years ago on the strength of the New York City 1964 code which at that time scheduled a stepwise reduction to a 2.2 percent maximum sulfur by October 1969. Before the facilities were even completed, the ground rules and the target had changed so that this facility was practically useless to them. More recently the target and the date for achieving it have again been changed and they will require an additional investment to meet the new goals—which is a pretty wasteful way of doing it.

One of the other major companies recently announced that they are going to invest $120 million in their big refinery in Venezuela to desulfurize their residual fuel for the east coast market and I presume they are planning to bring the sulfur down well below 1 percent. That is a big investment.

Mr. DADDARIO. This is an answer to a question I previously asked. Your ability to improve the situation is somewhat encumbered by the fact that you might make the necessary capital investments to reach a certain standard, and then find that that will not accomplish what the regulatory agencies want. It puts you in a position where you have a plant which is brand new and is perhaps not even used?

Mr. GAMMELGARD. Yes.

Mr. DADDARIO. A plant which is now obsolete though better than what you have and still unable to meet the requirements. We would like to have some understanding as to that before you make such capital investment.

Mr. GAMMELGARD. That is right.

Mr. DADDARIO. There is already at least one incident, and others, where such investments have been made to meet an improved criteria which you have already been advised is inadequate?

Mr. GAMMELGARD. That is correct. I know of one such company.

Mr. DADDARIO. Is it possible that you can get the background of that situation so that we may have it for the record, Mr. Gammelgard?

Mr. GAMMELGARD. I believe so. I will ask them, certainly.

Mr. BELL. Where is the gravity of a black oil where you have a considerable problem with sulfur and the higher oils or lighter oils where you don't have, such as you just described? What gravity is that?

Mr. GAMMELGARD. A typical No. 6 is around 12° A.P.I. gravity, just a little bit lighter than water.

Mr. BELL. You are talking about real heavy oil?

Mr. GAMMELGARD. Real heavy. With a high B.t.u. content per gallon. Much higher than gasoline or propane.

Mr. BELL. As far as most of the companies are concerned, the overwhelming amount of oil they sell then is really the higher gravity oil?

Mr. GAMMELGARD. That is correct.

Mr. BELL. You are really talking about the bottom of the barrel at the refinery. In other words, you have a breakdown for lower ends in your fuels; is that what you are saying?

Mr. GAMMELGARD. Yes.

Mr. DADDARIO. Proceed, please, Dr. Eckardt.

Dr. ECKARDT. It should also be noted that once an air quality standard has been adopted the question of how best to achieve it still must be answered. Because of variations in meteorologic and topographic conditions, types, and concentrations of industry, prevailing fuel use patterns, and other factors, translation of air quality goals into specific control measures—or emission standards—is a complex task.

If pollution is to be controlled—as we believe it should be—on a cost effectiveness basis, there is a real need for research into methods of determining what combination of control measures can do the best job at the lowest overall cost to the community.

Unless such research is undertaken there will inevitably be a tendency for one jurisdiction merely to copy the actions of another, whether appropriate or not. The result could be wasteful expenditures in some areas and inadequate control in others.

Meanwhile, the development of better methods for determining what specific control measures are needed to accomplish specific air quality objectives should be an item of the highest priority. Otherwise, our air pollution control efforts may fail to produce the desired effect on air quality.

In concluding, I should like to make one observation concerning an aspect of the Air Quality Act which we may tend to overlook. Under the abatement conference procedure established back in 1963, which also carries over into the new law, the Federal Government still can and does recommend specific control measures for pollutants on which no criteria have been issued. Certainly the control measures recommended and adopted under these abatement procedures ought to be subject to the same tests of economic and technologic feasibility.

I want to thank the committee once again for the opportunity to appear here today.

That concludes my statement.

With your permission, I would like to address myself to a question asked yesterday of Mr. Ryan. I see he is not here today. I don't think he got a good answer and I think I can give a little better one.

Mr. DADDARIO. Will you restate the question and tell us your answer?

Dr. ECKARDT. He inquired yesterday about what action was taken by New York City during the November 1966 air pollution episode and I got the impression that he left here and maybe the committee felt that no action was taken. This was not true. In fact, three steps were taken in New York. Consolidated Edison was asked to use the lowest possible sulfur content fuel they could. Incineration in apartment houses, and the city incinerators was stopped and people were asked voluntarily not to drive into the city.

Then another corollary question he asked was, does New York have a plan? Well, this is part of it, but there is an additional plan that is available in New York for action if they have another air pollution emergency. I happen to serve on the Medical Advisory Committee for the Air Pollution Control Authority up there and they have recently asked us to review this plan and in essence we approved it, from a medical standpoint, with one exception, and an interesting one, and that was that they had recommended that the heat in apartment buildings not be permitted to exceed 60° Fahrenheit. We, on the medical advisory committee, thought that this was too low a temperature and would probably cause more hardship and perhaps more deaths than the air pollution itself, so we recommended this be raised to 68° Fahrenheit. But other than this one recommendation, the plan was approved and so far as I know it is in effect in New York City.

Mr. DADDARIO. Dr. Eckardt, having brought up the question of a serious episode coming about, let's say one even more serious than the Thanksgiving episode 2 years back, should there not be a plan which can take effective action? Should there not be, for example, the ability to prevent unnecessary traffic in New York and have some way to enforce this?

We ought to be able to do much more than to say to people, "We would like you to do this" if in fact it could cause great harm to a great number of people.

Dr. **Eckardt**. In effect, the plan developed by New York, depending upon the levels of air pollution measured, goes from voluntary action to mandatory action.

When the mayor of the city of New York declares a state of emergency, they can prevent traffic from coming into the city because you have to cross a bridge or a tunnel or something to get into New York City and I know during one of the heavy blizzards that they had in New York, as a New Jersey resident, I was not able to get into New York with my automobile because they would not let you through the Lincoln Tunnel, or the Holland Tunnel.

Mr. **Daddario**. Does your knowledge of that situation give you the ability to answer as to whether or not the mayor does have the ability to declare a state of emergency in the case of air pollution, or does the law confine him to certain other things such as snowstorms? Has the necessary step been taken so that he might declare a state of emergency for this purpose and would not the state of emergency under this set of facts compel him to do different things? I would imagine there would need to be hospitalization of certain people. Perhaps even moving them from a city.

Dr. **Eckardt**. All of this is incorporated into the plan. I don't know the legal implications because I am not a lawyer and whether this would hold up in court, but my understanding is that he does this under a general type of law declaring a state of emergency and then under this he can make the individual adhere to certain regulations which he issues.

Mr. **Daddario**. It may be that the plans to meet such emergencies seem to be more tenuous than real and that they would necessitate a great deal of improvisation. We are not going to come to an answer about that now. But certainly it does call upon us to follow through, as Mr. Gammelgard has said, to have monitoring capabilities which are adequate, and then to take other steps when the situation requires it. Otherwise the monitoring system would be unnecessary.

Dr. **Eckardt**. My understanding, Mr. Chairman, is that in Chicago, Mr. Stanley, who is head of their air pollution control department, has what he calls a "hot line" to the utility companies and when the air levels on his telemetered monitoring stations get to a level where he feels something should be done about it, then he calls the utilities and suggests that they change also to a lower sulfur fuel.

Mr. **Bell**. Dr. Eckardt, to what extent is the American Petroleum Institute, which includes most of the large oil industries in the Nation, involved in gas production as compared to fuel oil?

Dr. **Eckardt**. I don't really know. Would you like to answer?

Mr. **Gammelgard**. I will make a general answer to that, if I may. In the production of crude oil almost invariably gas is produced along with it, to a widely varying extent. The gas-oil ratio can be all over the map. So we in the oil business are involved in gas production too. However, well over half of the natural gas produced in this country comes from gas wells which produce no crude oil.

Mr. **Bell**. As I understand your testimony earlier, it would indicate to me that gas is less a source of a pollutant than is fuel oil, is that right?

Mr. **Gammelgard.** In comparison with a 1 or 2 percent sulfur residual fuel oil, yes, that is correct.

Mr. **Bell.** To explore that further, would it not cost you less to make your gas controls, whatever they need to be, than to make the necessary changes in the fuel oil to eliminate your sulfur.

Mr. **Gammelgard.** There is a limit, of course, to the gas reserves in the country and if the gas reserves are used to, say, fuel all the powerplants in the country, with the big increase in demand that is forecast for power in this country, I think we would seriously dip into our reserves. Secretary Udall a year ago was very concerned and said publicly, that the reserve ratio, that is, the number of years supply of gas to current annual consumption, is steadily dropping and he doesn't want to see it drop because if that continues too long we will run out of gas.

Mr. **Bell.** Aren't we in the same position as far as production of any kind of oil is concentrated? Do we have unlimited amounts of resources of oil?

Mr. **Gammelgard.** No, we do not, but when I refer to the reserve ratio I am tying it to the known reserves of crude oil to the current consumption of crude oil. That ratio has not been dropping in the same manner. The gas reserves to consumption ratio has been dropping, and I think it is currently about 16.5 to 1. Secretary Udall wants this down-trend reversed.

Mr. **Bell.** As I understand it, earlier you said there is always a certain amount of gas, and in many cases there is too much gas over oil. When you find a new field you also find gas with oil.

Mr. **Gammelgard.** Some of that gas is used to repressure the formation so as to eventually produce more of the crude from the formation and it is not sold as gas to consumers.

Mr. **Bell.** Eventually, when you get the crude out, you then get the gas out too.

Mr. **Gammelgard.** Yes.

Mr. **Bell.** You can probably see what I am coming to. If gas is less of a pollutant, and if all of the oil companies produce as much gas as they do oil and maybe more, why wouldn't it be a good direction for the oil companies to start moving toward the production and sale of gas and thus eliminate the pollutant problem, the costs and so forth. This would be the direction you could go and save yourself a lot of money.

Now, is this a practical suggestion?

Mr. **Gammelgard.** I think that is what has actually been happening. If you examine the last 10 years, the annual increase in gas consumption in this country has exceeded the annual increase in petroleum liquid products. Gas consumption has grown at a substantially higher rate than the growth of the liquid petroleum products.

Mr. **Bell.** In other words, you are saying the gas is taking over your competition? Is that also true?

Mr. **Gammelgard.** It is taking over some of the markets formerly served by other fuels, such as coal and oil. Large scale substitution of gas for residual fuel in the east coast market would have a very serious impact on the economies of friendly Caribbean nations now supplying fuel oil to this market.

Mr. **Bell**. In other words, the sale of gas is becoming a little bit more competitive, as it is right now, even without your economic changes in sulfur content. It is still becoming more of a competition to you in the sale of your products, is that right?

Mr. **Gammelgard**. That is correct, but I would like to also point out that gas is not a nonpolluting fuel. Combustion of gas makes nitrogen oxides the same as other fossil fuels do.

Mr. **Bell**. You did give me some tremendous figures involving the cost of sulfur elimination. You did not give me any such figures relating to the elimination of pollutants in gas, so I am assuming that it is less expensive to eliminate pollutants in gas. I think you testified to that effect.

Mr. **Gammelgard**. Yes, that is right.

Mr. **Bell**. Then the only argument I can see that you have is that you might run out of gas, but you won't run out of heavy oil.

Mr. **Gammelgard**. I don't think we will run out of crude oil.

Mr. **Bell**. That is a debatable point.

Mr. **Gammelgard**. Some day, of course.

Mr. **Bell**. The other point would be, why wouldn't the industry be wise to think in this direction?

Mr. **Daddario**. I think you have answered that question.

Mr. Brown.

Mr. **Brown**. No questions

Mr. **Daddario**. I would then like to go to Dr. MacFarland's statement.

(Dr. MacFarland's biography follows:)

DR. HAROLD N. MACFARLAND

Education.—University of Toronto: B.A., 1941; University of Toronto: M.A., 1942; University of Toronto: Ph. D., 1949.

Present Position.—September 1965 to present. Director, Inhalation Division, Hazleton Laboratories, Inc.: Directs the overall research and applied programs for the Inhalation Division encompassing the fields of respiratory physiology and pharmacology, inhalation toxicology, industrial hygiene and air pollution.

January 1965 to present. Vice President and Director, Resources Research, Inc. (subsidiary of Hazleton Laboratories, Inc): Assists in corporate planning for Resources Research, Inc.; provides toxicological interpretation of air pollution findings; acts as liaison between RRI and Hazleton Laboratories, particularly with respect to performance of research in air pollution involving biological effects.

Experience.—1962–1965. Senior Toxicologist, Hazleton Laboratories, Inc.: Research coordination and development in environmental health; toxicological consulting in the field of military industrial chemicals.

1952–1962. Department of National Health and Welfare, Ottawa, Canada: Assistant Chief, Occupational Health Laboratory (1952–1954); Head, Research Group, Occupational Health Division (1954–1959); Senior Scientific Officer, Biological Unit, Occupational Health Division (1959–1962): Evaluation of pesticide hazards in orchards; supervision of problems in air and water pollution; experimental therapeutics in pulmonary edema; evaluation of hazards from thermodecomposition of plastics; fundamental studies on respiratory function; toxicological and pharmacological evaluation of pulmonary irritants; statistical design and evaluation; design of equipment for studies with airborne toxicants.

1949–1951. Chief, Toxicology Section, Defense Research Medical Laboratories, Department of National Defense, Ottawa, Canada: Toxicology of fluorine compounds, toxic gases and anticholinesterase agents; chemical warfare.

1941–1949. Department of Physiological Hygiene, University of Toronto, Canada: Research Assistant (1941–1943); Research Fellow (1943–1947); Senior Research Fellow (1946–1947); Lecturer in Industrial Hygiene (1947–1949). Synthetic organic chemistry; metabolic studies of foreign organic compounds; experimental therapeutics in heavy metal poisoning; toxicology of organic compounds, heavy metals and airborne toxicants.

Professional Memberships.—

Air Pollution Control Association (company representative);

American Association for the Advancement of Science;

American Public Health Association;

American Industrial Hygiene Association;

Canadian Federation of Biological Societies;

The Canadian Physiological Society;

The Pharmacological Society of Canada (charter member);

Society of Toxicology (charter member);

Consultant, Threshold Limits Committee, American Conference of Governmental Industrial Hygienists;

Member, Z-37 Committee of American Standards Association;

Certification from the American Board of Industrial Hygiene in the Toxicological Aspects of Industrial Hygiene;

Member, Editorial Board, Toxicology and Applied Pharmacology.

STATEMENT OF DR. HAROLD N. MacFARLAND, HAZLETON LABORATORIES, INC.

Dr. MacFarland. Mr. Chairman and gentlemen, I thank you for the opportunity to present testimony to this committee.

My primary purpose today is to describe to you two large experimental investigations having to do with the biological effects of air pollutants which are presently being conducted at Hazleton Laboratories, Inc. Hazleton Laboratories is an independent life sciences research firm which performs contract research for Government and industry. Its laboratories are located just a few miles from here, near Falls Church in northern Virginia.

In the last 2 days the need for additional knowledge in order to determine meaningful criteria and to set objective standards for air pollutants has been emphasized more than once. Specialists in this field have been aware for many years of the deficiencies that exist in our knowledge, but it has been only comparatively recently that adequate funding has become available to undertake the rather extensive investigations that are required.

What are the deficiencies and what needs to be done? Examination of existing experimental studies on the biological effects of air pollutants reveals a pattern which is readily understandable. The first investigators—toxicologists, physiologists, and scientists from cognate specialties—examined some of the simple gaseous pollutants, such as sulfur dioxide, in short-term or acute studies. In order to increase the chances of seeing biological responses, they worked with very high concentrations of these agents. And since one tends to do the simple and inexpensive thing first, these early trials were performed with small laboratory rodents as the test species. The measures of response in these animals were also simple and obvious—gross pathological damage and death. Although it was appreciated that human populations are scarcely ever exposed to just a single pollutant, investigators nonetheless usually only looked at single pollutants and almost no work was done with mixtures of pollutants.

But what is the real problem that confronts us? We want to know the effects of pollutants, particularly mixtures of them, on human subjects undergoing very long-term exposures to quite low concentrations. So, it would seem that the work that had been done was just the opposite of what was needed. And, to add the coup de grace, enough was known about the effects of air pollutants on human populations to realize that certain predisposed individuals—the respiratory cripples, asthmatics, chronic bronchitics and cardiopulmonary cases—were especially liable to adverse effects. But there were no analogous experimental studies on such special types of population; that is, animals in which a functional impairment had been established before exposing them to pollutants.

We approached representatives of the coal-burning electric power utilities a few years ago with the suggestion that biological studies be undertaken in which many of the defects seen in earlier work would be overcome by means of adequate experimental design. In due course, the Edison Electric Institute and the National Coal Association, with minor contributions from two or three other sponsors, authorized a five-and-a-half-year series of investigations at a cost of $2.2 million. A recent analysis indicates that the program will actually require 7 years to complete and the total cost will be $3.3 million. The work on this program commenced in June 1966, a year and a half prior to the adoption of the Air Quality Act of 1967.

Mr. DADDARIO. Has that 7-year and $3.3-million proposal been approved? Do you have the funds for it? Are you going ahead with it?

Dr. MACFARLAND. We haven't the funds for it yet.

Mr. DADDARIO. You have the funds for the 5-year study at $2.2 million, but do you expect the same people would support the additional expenses?

Dr. MACFARLAND. We have hopes of getting an additional sponsor now to provide the remaining $1.1 million that we need. In the months preceding the authorization of this contract in June 1966, we had approached the U.S. Public Health Service to see if they would contribute to the financial support of this project. They refused. More recently, particularly with the enactment of the Air Quality Act, we believe there is a possibility now that they may be prepared to reconsider their earlier decision. So we have started to approach them with a view to seeing if they might provide the additional $1.1 million that will be needed to complete the program.

Mr. DADDARIO. Was the Public Health Service refusal based on financial reasons or was it based on their disagreement with the way in which the studies would take place?

Dr. MACFARLAND. I think for financial reasons. The history of the development of this project, and the design of the experiments is a rather long and involved one, and the opinion of experts in the field was solicited many times before the project took its final form. Among the experts whose opinions were sought were some from the Public Health Service, so that when the final proposal was prepared it carried the imprimatur of the Public Health Service. They had no objections from a technical point of view. I assume, then, it was a financial limitation that resulted in their refusing to help at that time.

Let me give some of the details of the design of this study. The pollutants selected for examination are sulfur dioxide, a gas; sulfuric acid mist, a droplet aerosol; and fly ash, a particulate aerosol. These are the three most conspicuous pollutants emitted from the stacks of coal-burning powerplants. Graded levels of these substances, spanning the range of concentrations that have actually been measured in polluted urban atmospheres, are being employed. Exposures are being conducted in large chambers operated on an around-the-clock basis so that the daily exposure exceeds 22 out of the 24 hours, 7 days a week, for uninterrupted periods of a year or a year and a half. Two species of animals are under test, guinea pigs, which get the 1-year exposure, and monkeys, which get the year and a half. The greater emphasis in the work attaches to the primates, and it is rather easier to extrapolate from the monkey to man than to make the jump from a mouse to man. Guinea pigs were included in order to provide a connecting link with some of the earlier published studies. In the various trials which make up the complete program, the animals are being exposed not only to the single agents, but also to some of the binary and ternary mixtures of them. It is not feasible to examine all of the theoretically possible combinations, but an adequate and representative number of them have been selected.

Let us turn now to a most important consideration—the measures of response in the animals. In a biological study of this magnitude and duration, it is customary to perform certain conventional or routine tests. Thus, basic hematological and clinical parameters, X-rays, electrocardiograms, and growth data will be collected throughout the study. However, we do not anticipate that any striking changes will be seen in these variables, although we may be surprised.

Our interest is focused intensively on the results being obtained from a battery of very advanced and highly sensitive pulmonary function tests. These include measures of the mechanical, ventilatory, and diffusional characteristics of respiratory function. With the aid of an online computer facility, about 3 dozen primary and derived parameters are obtained. The tests are performed on all animals on a scheduled basis prior to, during, and at termination of the exposures. It is possible to apply these tests on this repetitive basis because they are what we call nondestructive, that is to say, the animal under examination requires no anesthetic, operative procedures or other techniques which would interfere with the test or preclude its repeated performance. It is only at the termination of the year or year and a half of exposure that we add one or two final tests that will render it necessary to sacrifice the animal after conducting them. At this point, a thorough gross and microscopic examination of all major tissues and organs of the animal completes the experimental phase of the investigation.

Although this program was authorized a year and a half ago, it is too early yet to speak of the results which are beginning to accumulate. When the results are available from each series of exposure trials, the final phase of the investigation may be entered into. This will be an evaluation and interpretation of the findings as they relate to the standards for the specific pollutants and their mixtures. The objectives of the study, then, are of a quite practical significance.

Mr. DADDARIO. Mr. MacFarland, what are the difficulties in extrapolating this information obtained through your animal studies to man? What do we learn? How far can we go? What do we then need to do? Where do your studies bring us?

Dr. MACFARLAND. This is a long and difficult question.

The experimentalist is always asked, How do you get from your animals to man? It must be admitted that all or nearly all work with experimental animals has as its ultimate objective something that applies to man.

Experience has shown that if you work with an organism or species which is far removed from man on the phylogenetic scale, if you work with a mouse rather than, say, with a dog, the danger of extrapolation that you will ultimately make is increased. It is, therefore, as a general rule, considered a little safer to jump from, let us say, a subhuman primate to man. What kind of results are we talking about and what is this jump? One of the things that may be of interest to you is the qualitative nature of the responses you are seeing. If you do examine the effect of something on a series of animals moving up the phylogenetic tree and you see much the same kind of effect occurring in each one of them, you will feel fairly confident that if man were exposed to the same thing he would exhibit the same signs and symptoms. You can appreciate that if you had only done the work with mice and then jumped to man that there is a possibility that there might be a striking species difference which would vitiate your extrapolation.

So there are these questions of the qualitative similarities that may or may not be present when you do this kind of work. There is also a question of the quantitative nature of the responses and the same sort of considerations apply.

Now, as to the next part of your question, suppose we had results in various species, including the primate, and we want to jump over to man, can we do this, or what other work is indicated? One of the things, of course, that one would like to think of as a theoretical possibility, perhaps, is: Could we do experiments on men? This question is not at all ridiculous and, in fact, we do do experiments on men.

One of the factors that will govern this is the nature of the kind of things we are working with and the nature of the effects they produce.

It is fortunate, in this sense, that the sort of pollutants that I have been talking about are not noted for their high toxicity. They are irritating materials and they do fall into a class where considering the possibility of doing human experiments is quite on the books. As a matter of fact, we have proposed to our sponsors in a tentative form a possible continuation of some of the work that we are doing in human subjects. However, there are difficulties. I mentioned at the beginning what we really want to know is the effect of very low concentrations of these pollutants over protracted periods of time. Well, you can put an animal in a chamber and conduct experiments on him for a quite high fraction of his total lifespan or, in fact, for his total lifespan, but you cannot do this with human subjects. So it is a little difficult at the moment to see how we can perform the necessary experiments on human beings. Short-term ones we can do, but short-term ones are not what we are really interested in.

I seem to have talked around this question, Mr. Chairman. I do not know whether I have answered your question.

Mr. DADDARIO. Well, we can get into it more deeply later. I do think this is important to us, however, so that we might know what time scale we are talking about and how, in fact, we can have confidence in criteria to be established through such laboratory techniques, recognizing they are extremely important. I do not assume that this is not an important piece of work to be doing because it is; it is just that we ought to have it generally recognized what the limitations are, both to know what it can accomplish and what it cannot.

Dr. MacFarland. Yes.

In my opening sentence I referred to two large air pollution studies in progress at Hazleton Laboratories and I would like now to give a description of the second program. You will be pleased to learn that this can be done rather briefly and without quite so much detail.

By way of background on the second study I will remind you that there have been a few air pollutant visitations sufficiently severe to be labeled "disasters." The London smog of 1952 is the most well known of these disasters and some 4,000 excess deaths were attributed to it. Monitoring stations were in operation during that "killer smog" and levels of sulfur dioxide and suspended particulate were measured. The maximum sulfur dioxide concentration, recorded briefly at one station, was 1.34 parts per million; the peak level of suspended particulate matter was 4.46 milligrams per cubic meter. To the air pollution control officer, the increase in the concentration of both these pollutants over background levels was the salient observation; but, to the toxicologist, the absolute value of the concentrations, vis-a-vis the mortality incidence, appeared anomalous. It is true that those who succumbed were, for the most part, not healthy adult men but, rather a group suffering from preexisting cardiopulmonary insufficiency, or else were very young or very old. But, even allowing for these facts, it is still difficult to see how such toxicologically low levels of sulfur dioxide and suspended particulate matter could elicit such a drastic response as death in 4,000 victims.

Some theories have been advanced which, if true, might explain the observations just cited. One of the more promising ones has to do with what is called a synergistic effect. This is an enhanced response to a mixture of pollutants greater than would be expected from the sum of the responses to each component when acting singly. You can probably anticipate what a review of the literature on synergistic effects among mixtures of common air pollutants is going to reveal. Very few studies have been performed. Those that have are of a short-term, acute nature, employing unrealistically high concentrations of pollutants, and they have been conducted exclusively in small rodents.

In 1966 we suggested to members of the American Petroleum Institute that a study of synergistic effects, in which the deficiencies noted above had been corrected, was worthy of support. In January 1967 the American Petroleum Institute authorized our proposal for a 3½-year program, costing $1.6 million. The details of the design and the battery of test procedures are quite similar to those in use in the power utilities program. Again, the main test species is the primate, although a limited amount of work in rats is also being performed. The main points of difference should be mentioned. The pollutants under examination are the gases sulfur dioxide, carbon monoxide, and nitrogen dioxide, and two particulates, lead chlorobromide and calcium sulfate. Lead chlorobromide is the main lead compound found in the exhaust of automobiles using leaded gasoline as fuel.

Calcium sulfate typifies the ubiquitous "particulate sulfate" found in urban atmospheres. The effects of these five materials acting singly are being determined in several trials, but the bulk of the work will be performed on a selection of the various gas-gas and gas-particulate combinations. At the end of the study the computer will help us perform the rather complex statistical analyses of the data that will reveal whether or not synergistic actions have occurred and, if so, their magnitude. When we consider that human populations are almost invariably exposed to mixed pollutants, the potential value of the results that will be forthcoming from the American Petroleum Institute study is evident.

Mr. DADDARIO. Dr. MacFarland, getting back to the preceding page, the last sentence of your statement on page 5: "Even allowing for these facts, it is difficult to see how such toxicologically low levels of sulfur dioxide and suspended particulate matter could elicit such a drastic response as death in 4,000 victims." You are talking about those who have a predisposition to such a situation. Can we assume that a higher concentration of such pollutants could affect great numbers of people who do not have such predispositions, since the death of so many allows you to come to this conclusion?

Dr. MACFARLAND. Yes; it is undoubtedly true that a normal subject would be adversely affected if the concentrations were high enough. The question that remains, then, is: How high is high enough? And some of the types of experiments we are doing, hopefully, will give some indications in this direction.

Mr. DADDARIO. Would you assume because people have died from such concentrations whom you would not expect to, even though they have a predisposition, that you could take the next logical step and say that healthy people subjected to high concentrations would also die? If that is so, then we are talking about a very dangerous situation because you are talking about the possibility of death of an untold number of people who somewhere in this scale will be affected as these 4,000 were?

Dr. MACFARLAND. I think this may be possible. The difficulty here is that we are talking about something where we simply do not know the answer at this point. We have not enough knowledge. Many people cannot even smell a concentration of sulfur dioxide of one and one-third parts per million. This particular visitation lasted about 5 days. Now, it is inconceivable on toxicological evidence that a person could not stand one and a third parts per million of sulfur dioxide for 5 days. Let me bring in something that may illuminate this a bit.

I sit on a committee which is concerned with the establishment of threshold limit values. These are numbers to be used in industries which produce airborne hazards and they purport to be a sort of maximum allowable concentration that a normal working man can be exposed to for 8 hours a day, 5 days a week, for a working lifetime of 40 to 50 years without adverse effect.

Now, what is the threshold limit value, this industrial standard, for sulfur dioxide? The value currently used is five parts per million. This standard has been in existence for many years and there simply is no evidence to indicate that it is too high, We do not anticipate that this number will be revised downward on the basis of any evidence presently available. So then if this number is a valid one, and it must be admitted that the reliability of these numbers in the threshold limit value list varies from number to number, depending on the evidence that lies behind them, but if we accept the five parts per million then this standard purports to say that a man can be exposed 8 hours a day to five parts per million for 5 days a week, for 40 to 45 years. Now, maybe this will help you to get an impression of the kind of thing that makes me say that one and a third parts per million of sulfur dioxide is toxicologically a pretty low concentration, particularly when the one and a third was only a peak value seen very briefly at one station, while the average concentration was below this and the whole duration of this episode was about 5 days.

So, there is some kind of a quantitative anomaly between what are really, toxicologically speaking, low levels of these things as compared with the very drastic outcome, 4,000 people dying, which is a pretty severe response.

Mr. DADDARIO. Dr. MacFarland, I think this has some bearing on it. The New York Times this morning has an article on emphysema and the effect of air pollution. I would like to pass these to all of you just so that you can take a look at them, in case you have not seen the article. The article says:

> Emphysema, the lung disease that often suffocates its victims, strikes earlier and pushes them faster toward death in air-polluted industrial cities than in nonindustrial, unpolluted communities, experts said here this week.

It goes through to prove these points and concludes then by saying:

> There was more emphysema in St. Louis than Winnipeg, it was evident at an earlier age and appeared to progress more rapidly.

It goes on:

> The importance of environmental pollution is suggested by the fact that the incidence of severe emphysema in smokers is four times as high in St. Louis as it is in Winnipeg.

Taking what you have said and extrapolating this into the overall situation, it indicates that there are varying degrees of severity, that people with a predisposition, with a disease such as emphysema, can be more affected in an industrial area. I would think that people who do not have thep redisposition are also in a more dangerous situation as a result of finding themselves in a highly industrialized area where high pollution percentages exist.

Dr. MACFARLAND. Yes, but this needs to be analyzed a little further. The people who succumb, or the bulk of the people who succumb in this kind of disaster, are the respiratory cripples. These people have one foot through the door anyhow.

Mr. DADDARIO. So do we all.

Dr. MACFARLAND. It takes a very little to push them over. If you were to place a normal individual, a person with adequate pulmonary function, we will say, into this kind of an atmosphere, this is not going to bother him at all. Suppose that a normal person lives in this kind of atmosphere over a long period of time—suppose he grows up in this industrial area and he begins to develop the early changes, which if they go on to completion, will lead to emphysema and other respiratory diseases. He is not a normal, healthy individual, he has already suffered the beginnings of a process that will result in overt disease ultimately. If you put this man in a heavily polluted atmosphere such as may occur in one of these incidents, you would anticipate that he would tend to be adversely affected more severely and sooner than a stranger who just happened to be visiting this city at the time and who was completely normal.

Mr. **Brown.** Mr. Chairman.

Mr. **Daddario.** Mr. Brown.

Mr. **Brown.** May I just interject a thought here. I think what you said is absolutely correct, Doctor, but don't we also need information as to the extent or degree to which these so-called pulmonary cripples have been created by these same conditions at a lower level prior to the episode? Obviously we do not have this information? But if there is any basis for this assumption that the pulmonary cripples are more susceptible to an episodic situation—and this is created by the same kind of conditions—then the episode merely adds the final touch to something that has been created by the lower conditions over a period of many years. Therefore, what I am asking is: Don't we need considerable information about the degree to which the cripples themselves may have been created by the lower concentrations of some of these contaminants over a long period of time?

Dr. **MacFarland.** Yes, indeed we do need this information, and much has been done to try and garner this information. It is done in part by epidemiological techniques of looking over the history of what has happened, looking at the medical records and trying to correlate these with occurrences of elevated pollutant levels.

Again from an experimental point of view, it is rather difficult to envisage how could you try to simulate this kind of situation in human subjects. It can be done with experimental animals. The trouble is that this is going to be a costly and long term program.

Mr. **Brown.** The whole point of this New York Times article seems to be an environment in which the pollution exists compared with an environment in which the pollution does not exist. It will exist at these very low levels—was not St. Louis one of the cities mentioned?

Mr. **Daddario.** Yes.

Mr. **Brown.** St. Louis has never had an incidence of severe pollution comparable to the London incidence. The evidence seems to be quite clear that the incidence and severity of emphysema is substantially greater there than in any area such as Winnipeg where the pollution does not exist. Isn't this the kind of pollution you are talking about?

Dr. **MacFarland.** Yes, this kind of evidence is usual. It provides directives for us, and I do not see that there is any argument about the validity of this kind of thinking.

Mr. **Daddario.** I bring it up only because it seems to logically follow from your testimony. How do you view it? Because there is such a base of information and so many points of reference that you have to take into consideration, recognizing how difficult it is, it is information such as this which does have a tremendous effect on the public generally. They read into it almost what they want to. It is therefore more important that we, as we analyze this information, develop a mechanism through which confidence can be built.

Dr. Eckardt, do you have a point here?

Dr. **Eckardt.** I simply want to comment about the disease emphysema a bit.

The medical profession today really does not understand what causes emphysema but they do know there are several factors that contribute to it. We do know, for instance, that the asthmatic who suffers from pollenosis over many, many years may develop emphysema. It is conceivable, although I am not saying this is the case, that the pollen count in St. Louis is quite different from that in Winnipeg. Another factor that we know is of importance in emphysema production is genetics. The best example I know of is this isolated island in the middle of the South Atlantic called Tristan Da Cunha, where there was a population isolated since the time of Napoleon which reached a peak population of about 250 people in about 1960 or 1961. At that time this island threatened to erupt volcanically and these people were removed and brought back to England ultimately and examined. Over 50 percent of these people suffered from chronic bronchitis or emphysema. This is a highly inbred population, again suggesting that there is a genetic factor in the production of emphysema.

Finally, in a recent epidemiology meeting that I attended in New York in December of 1967, Dr. Patrick Lawther from England indicated that there is something in the particulate pollutant from a city which stimulates the growth of an organism called Hemophilus influenzae. This same organism is found clinically by the physician. It will be found probably in small numbers in anybody's throat culture, but it is found in large numbers in people who are suffering from acute bronchitis. We in the medical profession feel that this organism may be in some way related to bouts of acute bronchitis which also, we feel, are related to the production of chronic bronchitis and, ultimately, emphysema.

Now, this growth-stimulating factor present in the particulate matter from urban communities—and I presume that this was London though he did not elaborate on it—is also present in cigarette smoke and certain phenols have the same effect. It does not stimulate certain other organisms that do not seem to be related to bronchitis. The organism that he specifically mentioned was staphylococcus. The point I am trying to make here is that the factors we are trying to control in air pollution, even if they are related to chronic bronchitis and emphysema may not be known. We might well clear up the industrial pollution in these cities as suggested—the New York Times article is suggestive that this is related to industrialization—we might clean these up but we might not influence the incidence of emphysema one bit because of the other factors that might be involved, such as the pollenosis, perhaps materials in the air not related to or ordinarily considered pollutants and because of genetic differences between the population. I am sure there are genetic differences between the people who live in St. Louis and those who live in Winnipeg.

Mr. DADDARIO. Dr. MacFarland, I think we should proceed.

Dr. MACFARLAND. Yes.

Gentlemen, I believe that programs such as the two which formed the subject of my testimony will help to fill some of the gaps in our knowledge of the nature of the action of pollutants and the concentrations at which they occur, and thus contribute to the solution of the problems that concern us all—the development of meaningful criteria from which scientifically objective standards of air quality may be derived.

Mr. Chairman, you have intimated to several of the witnesses that you may invite them to pay a return visit to this committee. May I, on my part, extend to you and the members of the committee, taken singly or in mixture, an invitation to visit at your convenience the Inhalation Division of Hazleton Laboratories to see the programs I have described in progress.

Mr. DADDARIO. Considering the fact that you are looking for human subjects, that might be an ominous invitation.

Mr. Brown, do you have some questions of Dr. MacFarland?

Mr. BROWN. No.

Mr. DADDARIO. Dr. Eckardt, your last statement indicates to me that there is some question about the quality of air we should be striving to achieve. When you relate diseases to the effect that air quality may have in the initiation of these diseases, or the effect that they could have on the diseases already existing, I wonder if you have any view or theory about this? How do you, in fact, separate it? Or should it in fact be separated, recognizing that emphysema most likely does arise in a multitude of ways and recognizing, too, as I understand the New York Times article, it does not indicate that industrialization's pollutants cause emphysema but that it has a greater effect on those already having it? Then that gets us to the development of a capability to get air quality to the highest possible level we can, regardless of our lack of ability, lack of knowledge about the causes, effects and initiation.

Dr. ECKARDT. I am not sure just what the implication of this study is, not having read the original one, but I personally feel that air pollution is going to be controlled; it should be controlled, but it probably will not be controlled on the basis of health. I often like to make the example of the use of the sanitary toilet and sanitary sewers. This primarily arose because people got sick and tired of the stench of human excrement in the streets and they wanted to do something else with it, put it some place else. I personally think air pollution has a stench at times, it looks bad, and I think we are going to control it on this basis. I like to go back to when I was a boy traveling between Long Island and New York City past what now is the old New York World's Fair site and La Guardia Airport. Both of these areas were huge burning garbage dumps. As we used to go through Flushing at that time, we invariably as children used to go through holding our nose because it stenched so bad. This has been cleared up and not because it was a health effect, but because people apparently got sick and tired of this stench. I think basically we are going to clean up our cities, unrelated to health effects, and even before we find out whether or not there are health effects, other than the acute episodic health effects. I think we are going to clear them up, every city, to a certain degree, but I am concerned that this is going to have no effect on the health of the people of the United States even though we do clear them up, because I am not convinced, other than the episodic area, that health effects have clearly been demonstrated for low level, long-term air pollution levels.

This does not mean to say you do not clear it up for other reasons. I think you can clear up air pollution as a public nuisance. I think, for instance, in my town they have decided that they do not want people to burn leaves.

Now, I get nostalgic when I smell burning leaves, again because of my boyhood, I suppose, but some people do not like it. I do not think this has been demonstrated to be a health effect, but they do clean it up. They find other methods of disposing of leaves and I think we will do the same thing; as our technology improves, we will improve our air pollution control and clean up our cities, unrelated to health effects.

Mr. DADDARIO. Will you theorize a little bit on this, Dr. MacFarland?

Dr. MACFARLAND. I agree with Dr. Eckardt that this is probably how it will go. I agree, too, that the direct cause-and-effect relationship between low levels of pollutant and health effects has certainly not been convincingly demonstrated at the present. I believe, however, that in time, as the evidence comes in from studies such as the ones I have described, and others, that the evidence will become clear that there is a relationship and it will, hopefully, define just what sort of a concentration we are talking about. Is it true that if a man is exposed all his life to a tenth of a part per million of sulfur dioxide that he runs such-and-such a percentage increased risk of emphysema? Or should the figure be at 0.5, or at 1, or at 1.5? I think this kind of information will gradually accumulate and I think it will be found that there are, indeed, some levels at which health effects ultimately will be manifest.

Dr. ECKARDT. Let me say I do not disagree with this statement. I am only disagreeing, at present levels of air pollution in our major cities, I do not think there are chronic health effects.

Mr. BROWN. May I comment?

Mr. DADDARIO. Mr. Brown.

Mr. BROWN. I want to make a remark which I do not want to be construed as in any way bearing on the present witnesses. But several years ago I conducted a hearing on the effects of lead additives in gasoline and possible health effects upon populations as this concentration increased. We had some very able scientific witnesses there who, at the end of the time, left me almost convinced that the more lead we got in the atmosphere the healthier it would be.

Mr. DADDARIO. You did not believe that?

Mr. BROWN. No. It runs against the grain of what you might call just normal human logic. But science does run against the grain of conventional, normal human logic. I think that there is a very sound point which has been made here. I offer the possibility and ask for comment on the history of certain types of human disease resulting from biologic agents in which the process of human adaptability has seemed to be able to develop immunities and even strength as a result of this. I am not saying that the increased intake of pollutants is going to make people live longer, but in the nature of science and the human being, I suppose there is always this possibility that could occur. We seem to have, for example, in Vietnam evidence that the natives over there have learned to develop immunities to certain types of malaria, which immunities we do not have over here. What you are saying about low-level pollutants in the atmosphere of cities, is conceivable that we could develop immunities to these things and that we would not have a long-term health effect. Basically, we would seek to eliminate them ultimately for other reasons such as they are not esthetic or they represent a waste in the production process. Is this the sort of thing that you are trying to point to here? Do you find any sympathy with what I am saying?

Dr. **Eckardt.** I am not sure that there is an immunity developed to air pollutants in the sense that we know of immunity to bacterial agents. This is a different process to me. I am not convinced that you could develop an immunity to air pollutants. I do know one small piece of information that was told to me by a man who has been working with lead, who was doing tissue culture. This happens to be Dr. Leonard Goldwater, now on leave of absence from Columbia Medical School. He said he had a tissue culture individual working for him. That person used extremely pure ingredients in the culture medium and they would not grow until they added miniscule quantities of lead to the culture material. Then the tissue cultures grew. This type of thing suggests that there may be some—and I am certainly not advocating this—but there may be some level of pollutant that is not necessarily bad for us. I would not want to try to put my finger on this level right now, certainly.

Mr. **Brown.** The thing that strikes me from what you have said and for many other reasons, a much broader research concept than we probably have is envisioned so far for this whole problem. I think we need extensive monitoring systems and extensive reporting systems on the incidence of disease throughout this country and in areas where there are no pollutants, for example, merely to set standards by.

Dr. **Eckardt.** I agree with this.

Mr. **Daddario.** Of course, Dr. Eckardt, we have been defining this as against man. We must add plant and animal life to our determinations as criteria are established, because this is an important aspect of this whole thing. If in fact we can, one way or the other, establish that there are certain causes and effects in these areas and can prove it in a way so that confidence can be developed, our programs would be better supported. There is concern that there is danger to health. There is question as to whether there is or is not. Because we are in this ambivalent position, we are not really able to get these kinds of programs going as soon as we should. Those dumps you were talking about could have been cleared up a long time earlier if in some way action could have been focused, and probably should have been. We ought not to wait until you finally reach the point where it gets overwhelming. We in this committee feel a great responsibility in the legislative process of seeing if we can anticipate these problems, taking into consideration the very great danger that can come, and see if we can then be of help in solving them sooner rather than later.

Dr. **Eckardt.** I agree. I think we will clean up our cities. I do not think there is any doubt of this.

Mr. **Daddario.** The hour has gone by again. This is a subject which could keep us going throughout the balance of the day, but we will be in touch. We will see if we can take you up on your invitation some time, Dr. MacFarland.

Dr. **MacFarland.** It was meant seriously.

Mr. **Daddario.** I understand that. Thank you.

This committee will adjourn until Wednesday, January 31, at 10 o'clock, in this place.

(Whereupon, at 12:14 p.m., the subcommittee recessed, to reconvene at 10 a.m., Wednesday, January 31, 1968.)

ENVIRONMENTAL QUALITY

WEDNESDAY, JANUARY 31, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:09 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order. I would like all of our witnesses at this time to come forward, if you would: Dr. Weinberger, Dr. Pecora, who will be accompanied by Mr. Frank Clarke, and Mr. Everts. If you want to break in from time to time, gentlemen, you may do so.

Our hearings on environmental quality resume today with a discussion of water pollution. The concern of this subcommittee is that scientific and engineering resources be employed in a timely manner to assure a firm basis for administrative actions.

Water quality laws have preceded air pollution abatement by several years. States have now proposed standards for approval by the Federal Government. The adoption of these standards and the subsequent enforcement of abatement action will depend on the same sort of criteria which we have been studying in air pollution. The experience with the sequence of descriptive criteria leading to prescriptive standards under the water laws may be a valuable guide to research strategy for cleaner air.

The testimony we have received so far strengthens my feeling that improved waste management has been delayed because of wrangling arguments over the effects of contaminants in the environment and an inability to compare costs of abatement with benefits to air or water quality.

In water, as in air, the average citizen, industry, or local government has no trouble in reaching a decision to eliminate gross and obvious contamination. Floating matter, suspended particles, oil slicks, and foul smells in surface waters are being dealt with as quickly as facilities can be installed in most areas. Although further engineering development may increase capacity and efficiency in sewage and industrial waste treatment plants, abatement is not awaiting research results.

However, there is less certainly in dealing with subtle effects such as persistent chemicals in industrial effluents or the warm waters from a powerplant condenser. Particular problems, including mine drainage and eutrophication of lakes and estuaries add to the complexity of the overall water quality program.

With air, the primary criterion is that for breathing by human beings. Water for drinking purposes can be obtained from the most polluted source, although distillation may be necessary. But water has so many valuable uses that a spectrum of criteria has developed. A given stream may be consciously dedicated to a combination of compatible uses—but only if cause and effect relationships are known.

The Federal laws for water pollution began with the objective of simply keeping out debris which would obstruct boating and shipping. Today, the uses for which surface waters are preserved range from sport fishing and water contact sports to industrial processing, agricultural irrigation, and pumped storage for electricity generation. Criteria differ for each use. I expect these hearings to show our capability in achieving an optimum use of our water supplies.

Our first witness today is Dr. Leon W. Weinberger, Assistant Commissioner for Research and Development, Federal Water Pollution Control Administration, Department of the Interior. Dr. Weinberger was very helpful to us in our hearings in 1966.

He has been of help to us informally over the course of years, and always generous in donating his time and advice to our committee. We thank you and welcome you here again today.

(Dr. Weinberger's biography follows:)

DR. LEON W. WEINBERGER

EDUCATION

B.S. in civil engineering from the Cooper Union, New York, N.Y.
M.S. in sanitary engineering from Massachusetts Institute of Technology
Sc.D.—Massachusetts Institute of Technology

PROFESSIONAL AFFILIATIONS AND HONOR SOCIETIES

Fellow, American Society of Engineers
Water Pollution Control Federation
American Geophysical Union
American Water Works Association
Member of Society of the Sigma XI
Who's Who in Engineering
American Men of Science

PROFESSIONAL HISTORY

1966–Date—Assistant Commissioner for Research and Development, Federal Water Pollution Control Administration, Department of the Interior.

1963–1966—Chief, Basic & Applied Sciences Br., Division of Water Supply & Pollution Control, PHS, U.S.

1949–1963—Assoc. Professor of Civil & Sanitary Engineering, Case Institute of Technology—Dir. of Sanitary Eng., Research Laboratory.

1949–1962—Consultant in water supply, waste water disposal, and stream pollution to city, State, and Federal governments, and to more than 20 industries.

1947–1949—Research Assistant and Research Associate, Massachusetts Institute of Technology.

1943–1946—U.S. Navy Civil Eng. Corps. (Seabees).

1943—Eng. Draftsman—Designer—North American Aviation.

Participates in numerous international, national, professional, and technical advisory committees, including the following:

- World Health Organization (WHO)
- United Nations Educational, Scientific, and Cultural Organization (UNESCO)
- Organization for Economic Cooperation and Development (OECD)
- National Academy of Sciences (NAS)
- Office of Science and Technology—Federal Council for Science and Technology (OST/FCST)

STATEMENT OF DR. LEON WEINBERGER, ASSISTANT COMMISSIONER FOR RESEARCH AND DEVELOPMENT, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, DEPARTMENT OF THE INTERIOR

Dr. **Weinberger.** Thank you, sir. Mr. Chairman and members of the committee, I am pleased to appear before you to discuss research, development, and demonstration, R.D. & D., in water pollution control.

I will submit the formal statement for the record, if I may, Mr. Chairman, and abstract this full statement, and respond then to any questions.

Mr. **Daddario.** Proceed, if you will, please.

Dr. **Weinberger.** In my introductory statement I made reference to the second D of R.D. & D., because demonstration, as far as we are concerned, is one of the most important facets of our program in the prevention and control of water pollution.

In my statement I cover the following items: Role of R.D. & D. in water pollution control; cost and benefits of water pollution control; research and development programed planning; research priorities; industrial participation in research and development; allocation of research resources; some major water pollution problems; the scientific and technical bases for water quality standards; advanced waste treatment and progress; industrial pollution control progress; eutrophication and water quality criteria and use of water.

An effective water pollution control program consists of a number of elements; namely, scientific and technical answers and solutions, economic resources to construct and operate pollution control facilities, a strong enforcement and program implementation effort, adequate planning and administration, and competent manpower. Research and development is needed to provide new and improved analytical tools, scientific knowledge, and engineering controls. I, of course, do not intend to minimize the importance or role of research and development; however, we should recognize that many of the water pollution problems facing our Nation today can be alleviated by the application of existing technology. In fact, in the immediate future, the most significant progress will be made in this way. Through research and development, we will find solutions where none now exist, we will better define the effects of impurities on water uses, we will improve the effectiveness of available solutions, and we will reduce the costs of waste treatment systems. Gentlemen, I have complete confidence that we will find solutions—acceptable solutions, in my opinion—to all our pollution problems.

The solutions will be satisfactory from a scientific and technical point of view, but they will cost money. Although you may believe that it is obvious that pollution control will cost money, there are apparently many polluters who are unwilling to recognize any solution as acceptable unless it is a zero-cost solution. We shall seek these zero-cost solutions—indeed, in some instances, through wastes recovery or byproduct development, a profit may be realized—but we must be willing to pay for pollution control. What is meant by an economically acceptable solution is certainly to be the subject of considerable debate. Conventional cost-benefit analyses are not totally applicable because we are not able to define in a quantitative manner all the benefits of water pollution control nor assess the total damages resulting from water pollution. Research into the socioeconomic aspects of water pollution control may provide us with some of these analytical tools—tools which will enable us to evaluate the "intangible" benefits.

Our knowledge of the costs and benefits associated with water pollution control is rapidly improving.

The Federal Water Pollution Control Administration has just completed a study entitled "The Cost of Clean Water." This is in response to section 16(a) of the Federal Water Pollution Control Act, as amended, which directs the Secretary of the Interior to conduct a comprehensive analysis of the national requirements for and the cost of treating municipal, industrial, and effluent to attain water quality standards established under the act. The first analyses have just recently been completed as they were due for submission to the Congress in January, this month. These studies are extremely important because, although there is widespread agreement that water pollution is a significant, growing problem which must be dealt with, there are no firm estimates as to what the national requirements are, or what it will cost the Federal Government and other affected units of Government to achieve a satisfactory abatement level. Various cost estimate studies of municipal and industrial needs have been conducted in the past but they have not been sufficiently comparable in geographical coverage, time phases covered, cost criteria, types of facilities included, or in cost estimate technique to provide a fully meaningful guide to the national requirements and costs involved.

The cost of clean water study represents the initiation of what will be a continuing evaluation, aimed at developing more accurately the national costs of pollution control. Although it has not been possible to arrive at a completely definitive estimate of required costs, it is believed that the present study provides a more comprehensive cost estimate than has previously been developed and a sound base of information upon which to build future analyses. This estimate is expected to improve in accuracy with each yearly updating.

Mr. Chairman, the first volume of this report has been printed and copies can be made available to the committee and, as subsequent volumes become available, they will, of course, be provided to members of this committee and all Members of Congress.

Mr. DADDARIO. Do you have sufficient copies so that they could be distributed here?

Dr. WEINBERGER. Sir, I do not have sufficient number of copies for this, but I will see that we get them to you as quickly as we can.

Mr. DADDARIO. Fine.

As I understand it, Dr. Weinberger, the estimate for waste treatment, sanitary sewers and water cooling requirements, for fiscal years 1969 to 1973 is somewhere between $26 and $29 billion.

Dr. WEINBERGER. Yes, sir. I would like to start dwelling on the research and development program and planning.

I have taken figures 1, 2, and 3 out of the report, made it available to each member of the committee as a separate item.

(See charts in Dr. Weinberger's prepared statement appearing at conclusion of his testimony.)

Figure 1 (p. 193) illustrates the program structure and elements of the research and development program of the Federal Water Pollution Control Administration. It represents the framework within which we can plan our program, establish goals and determine needed resources to achieve goals, allocate available resources, and evalute the effectiveness of ongoing research. Subprograms 11, 12, 13, 14, and 15 contain the elements dealing with specific sources of wastes. One note, it includes such matters as mine drainage, oil production, animal feed lots, irrigation return flow, various industrial wastes, various sources of municipal wastes. Subprogram 16 is a general category containing the elements of pollution identification, fate and persistence of pollutants in the environment, water quality control, eutrophication, water resources planning and resource data, cold climiate research, and basic research; subprogram 17 contains the elements dealing with waste treatment; and subprogram 18 is the research on water quality requirements or effects of water pollutants on all water uses.

One of the purposes of introducing figure 1 is to indicate the scope of our research and development effort, ranging all the way from identification of pollution to various means for solving problems caused by pollution. The element 1608—water quality control encompasses pollution control techniques such as recovery and reuse, product modification, process change, elimination, dispersion, dilution, detention, diversion, and even environmental treatment, that is, treatment of wastes in streams. This structure for categorizing our research and development was established last year and we believe will facilitate interagency coordination and cooperation. The categories are compatible with those established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

The research program of the Federal Water Pollution Control Administration is directed primarily to the solution of water pollution problems.

In planning research, a major tack is to establish priorities of research within available resources and the directives provided by legislation. In our program, priorities are based on the needs, recommendations, and ongoing research of the following:

1. FWPCA regional directors and their staffs. They are knowledgeable of the problems as they exist or may develop in their respective regions (river basin);
2. FWPCA program directors at headquarters;
3. Other Federal agencies;
4. State and local agencies;
5. University professors and researchers;
6. Consultants and advisory groups;
7. Committee on Water Resources Research; and
8. Industrial groups.

The setting of research priorities and the allocation of research resources is still, to a considerable extent, based on a subjective analysis. The analysis, however, has considerable merit when carried out by competent, knowledgeable people who have available to them the information obtained from answers to the following series of questions.

I will not read the questions. Let me suggest that the type of question we are talking about which helps us establish our priorities is as follows: What are the problems in water pollution or water quality control? Having identified the problems, what answers and solutions do we need? When do we need these answers? What answers and solutions are already available? Who has or should have the responsibility for seeking answers? What are the chances and incentives for obtaining better answers? When will the research, development, and demonstration be completed? On the basis of answers to these questions, gentlemen, it is possible to establish priorities which can be assigned to the various elements which I have indicated on figure 1.

The implementation of approved program plans consists of a number of aspects and I have listed these in my report.

The allocation of resources: The research and development program of the FWPCA is conducted through both in-house and extramural support. The in-house effort is conducted at our major laboratories and field sites.

It is obvious that to have a successful research and development program, in addition to the competence available in the Federal Government, the best scientific and engineering talent in the Nation, including that available in the university and private research institutions, industries, and in State and municipal organizations, must be included in the national effort to control water pollution.

Mr. DADDARIO. Dr. Weinberger, when you talk about the best scientific and technical manpower available, how about the manpower presently existing which has the responsibility to maintain the waste treatment plants now in existence? I have a letter from a Mr. Charles Pitkat, of Connecticut, who works at the Vernon waste treatment plant. He and a group of people who work at these plants get together on occasion and try to help each other out from the standpoint of skills and abilities to do a better job. He says, and I quote:

> One place that you can improve treatment is in the operator field. We need much more training than is now available. With all the talk going on about making police professionals or technicians, why cannot an operator have this same interest? Because of the background of operators, such as basic education, age, available time and the like, it is extremely hard to have us qualify to become a professional engineer. Yet, there is nothing available that would enable us to go to, say, three or four years of night school and end up as an accepted technician in this field. Professional people are reluctant to talk to or deal with nonprofessional people. If you look around in the design end of treatment plants, I would say you will find not one engineer concern who has someone who operated a plant on his staff. And yet we are the people who have the actual contact and control of their design.

I bring that up because we talk about scientists and technicians, yet when we had the hearings some time ago it showed quite clearly that many of our waste treatment plants were not operating at their full capacity for no other reason but that the people who were working on them just did not have the capability to maintain them at the highest possible level. Therefore the plants were not doing as good a job as they ought to do.

There was a desire on the part of these people to be able to do more. It was suggested, as I recall it, that perhaps we create an itinerant group of technicians who could go from waste treatment plant to waste treatment plant. They would help make assessments and tell these people what could be done to improve the plants, and by so doing reduce the waste and pollution problem which presently exists.

You talk about scientists and technicians, and yet you leave out the people who turn the switch and who see these things deteriorate around them—people who want to do a better job and cannot.

Dr. **Weinberger.** Mr. Chairman, our agency has last month submitted a report on manpower and training. Again, I would be very happy to make copies of that report available. This report agrees with the chairman completely, that one of the big gaps in our pollution control effort is an effective treatment plant operation. As a matter of fact, in the projections of manpower needs, the greatest need was indicated in the treatment plant operator category. Within our program, we are initiating within the month a technical training program which will supplement our professional training program. The purpose of the technical training program is to help develop institutions or curriculums or courses very much along the line that the chairman has suggested as one of the ways of doing this. We have a number of proposals which we are currently reviewing to help establish perhaps 2-year courses, junior college courses, specialized technical courses, to supplement some of the limited work going on right now at various States and which we are doing in-house.

Mr. **Daddario.** Dr. Weinberger, is it possible to put together some competent teams and have them review the procedures that are going on in certain plants? They could develop a checklist and give the people who are there some information as to what can be done at the moment while such a program of training is going on. Is this something that we should do or not?

Dr. **Weinberger.** Yes, sir; we should do it. It has again been done to a somewhat limited extent. There are some of the manuals, a number of programs, night courses, courses available in some of the high schools, at some of the universities, for operators to receive some of the training. There have been some instruction manuals prepared. One of the areas of research that I dwell on relates to this from the point of view of research and development. One of the things that we are attempting to do is to come up with procedures so that a plant can be operated in a more effective way. It is much more than just the matter of trained manpower. I made the statement that if there is a gap between the research man and the practitioner or the designer, then there is a chasm between the designer and the operator.

Mr. **Daddario.** Which is the point this gentleman makes in his letter to me.

Dr. **Weinberger.** And there are at least two things: what the chairman has suggested is certainly a very critical matter. The second one which we would hope to accomplish through R. & D. is to make it possible to operate our treatment facilities with better control devices, better instrumentation.

Mr. **Daddario.** Are you talking about those plants we will be building or plants presently existing?

Dr. **Weinberger.** Presently existing, sir. There is no reason, with the advances being made in control technology and instrumental methods, why some of these plants cannot be updated so that we can operate these on the basis of their design, at least, which will result in a very significant step forward in pollution control.

Mr. **Daddario.** The updating, however, involves some assessment as to where it is now and what needs to be done. This is a gap that, if filled, could lift up the whole level of this particular effort and immediately cause some improvement, in fact, considerable improvement.

Dr. Weinberger. Yes, sir; unquestionably.

Mr. Daddario. Your hope is that we will be developing an ability to make such an assessment so that each community can, in an expeditious way, come to a determination as to where it stands or what can be done, and what it will cost, and how much more improvement will come about as a result.

Dr. Weinberger. Yes, sir; this is certainly one of the administration's goals, to accomplish this.

Mr. Daddario. Fine, Doctor.

Mr. Fulton?

Mr. Fulton. The question to me is: Maybe we are starting at the wrong end. Instead of being under the apple tree trying to catch the applies with our apron, why don't we go in from the constructive side, that is, the best use of water and air supplies, both for current use and for longtime purposes? Why don't we start like that instead of talking pollution? It should take in the whole field.

Dr. Weinberger. I certainly do not have any comment to make other than to agree with Mr. Fulton, that in looking at water pollution, water pollution is obviously part of a much larger water resource problem. The whole matter of effective utilization of all of our waters and water resource planning is one of the activities that is being undertaken by the executive branch through Water Resources Council, among other agencies. So that the need for an overview of our total water program is certainly in order.

Mr. Fulton. Instead of just putting our programs for 17 States on reclamation, why don't we in Congress have the programs for all States with an overall purview of the best use of the U.S. resources? You see, we limit, in the Federal program, reclamation to only 17 States. That takes in half of Texas and then goes on west but it does not affect the need of any State east of the Mississippi River.

Dr. Weinberger. I could not comment on reclamation.

Mr. Fulton. This is a trap. I am from Pennsylvania.

Dr. Weinberger. I was going to comment——

Mr. Daddario. Did you have to be advised that that was a trap?

Dr. Weinberger. No.

Mr. Fulton. I could see his light touch, he was feathering it a little bit.

Dr. Weinberger. I hope not. I was going to comment by saying that insofar as the water quality control aspects, the responsibility given to us by the Congress touches all of the States of the United States.

Mr. Fulton. My point is maybe we should have an overall view which includes these problems wherever they are rather than putting them just geographically by States or taking the end result of the problem, such as pollution.

Dr. Weinberger. I would say personally, I think the need for an objective assessment of our water resources and water utilization is certainly in order. I say this, having served on a committee of the National Academy which issued a report on alternatives in water management, which deals with the subject and dwells on the subject.

Mr. Fulton. I believe we have to watch that we keep the language so that the average person, such as we, Congressmen, can understand it. When you, Dr. Weinberger and your fellow scientists, and the chairman of the committee, Mr. Daddario, use words like eutrophication, wouldn't it be better just to call it clogging a lake through overenrichment? When I hear the word "eutrophication" I wonder whether it is building up or down, making hotter or colder. You see, I cannot tell just from the word what it means. I would imagine most of the people in the audience cannot.

Mr. Daddario. Doctor, the reason I put that word into my opening statement this morning was to see if I could get a reaction from Mr. Fulton. It was sort of a trap. The other day when that same word came up he went into the very root of it for some 5 or 10 minutes and I thought that he made a very good case. So I used it this morning.

Mr. Fulton. Having gone to Harvard, it gets to be difficult at times when they throw things out like that. I wrestled with them like a dog.

Dr. Weinberger, I was very intrigued by your extra "D" in R.D. & D. I must say I had hoped you would get better results from the Federal Water Pollution Control Administration because there you only have one "D." So could I make a suggestion to the Department that they correct that and give you the extra "D." You seem to want it.

I could point out to you that Abraham Lincoln had a story about Mary Todd, his fiance, later Mary Todd Lincoln. He said to her one time in an argument that actually while she had two "d's" in "Todd," God, for a long time, had been satisfied with one. So I hope you will be satisfied with one "D."

Mr. Daddario. We could carry that a step further, following Mr. Fulton's story: The "D" could be classified under "Divinity."

Seriously, however, a recent ruling of the Second Circuit Court of Appeals stated that the Federal Power Commission should not have licensed Consolidated Edison to build a Storm King Mountain plant without considering the total environmental impact, esthetic tranquility, et cetera. Do you know of any similar rulings? Are we now able to provide regulatory agencies with useful environmental information so that such determinations could be made? What implications, particularly in consideration of what Mr. Fulton said about taking a look at the whole thing, do you see in decisions of this kind which do include tranquility and esthetics?

Dr. Weinberger. Mr. Chairman, quite a bit of that information is available. We obviously need more. When the water quality standards program was established by the Congress we called together a group of experts to help us establish the criteria by which we could assess the various water uses.

The various water uses include not only municipal use, industrial, agricultural, propagation of fish and other aquatic life, but also water for esthetic purposes. These consultants, and I believe they were some 80 in number, reviewed the kinds of water that it would be desirable to have to protect all of these values. This has been issued in a report. I have a copy of it. I would be pleased to get copies to the members. It represents a rather thick document.

Mr. Daddario. This document which I now show you?

Dr. **Weinberger.** Yes, sir. It represents some of the best thinking, best available information dealing with the protection of our water for various uses. Some of the information is descriptive, some of it indicates we should be protecting the amenities, the senses of people, other recommendations are rather specific, scientific, quantitative, in such areas as toxicants, such areas as thermal radioactivity, and the like.

Mr. **Fulton.** Could I ask on that point?

Mr. **Daddario.** Have you finished?

Dr. **Weinberger.** Yes.

Mr. **Fulton.** The question comes up whether certain activities in various geographical areas are not socially destructive and should not be carried on. For example, the pollutants and the cost of cleaning up the pollutants might be more than the particular activity is either socially or economically worth.

In the case of rivers, how do we get around the fact that the Federal jurisdiction of rivers was originally limited to navigable rivers? That is, rivers used either for navigation by boats or logging, so that you had some small navigable rivers? How did the Government get jurisdiction? Would the Government have jurisdiction, for example, in the State of Pennsylvania where it is going to cost billions to clear up old mines, much more than was ever gotten out of them? Does the Government have jurisdiction, for example, in Pennsylvania and Ohio and other States to limit surface mining because it is going to cause so much trouble 1,500 miles down the Mississippi River? Should there be a limit? Can the Government move into such a field where we might just outlaw a whole industry as not being either economically or socially beneficial to the whole country?

I am on the Space Committee. When you see these new pictures of the earth from 200,000 miles out, we look like we are a sink. You can see the clounds twirling all over the earth, not just State by State. When we say we can come up with solutions, maybe that is a slightly inadequate statement.

So my point is basically, on jurisdiction, How do we approach this? Is this a new field or an extension of the old?

Dr. **Weinberger.** I do not think I am really competent to talk about all of the jurisdictional matters which you raise.

Mr. **Fulton.** You can put a statement in the record.

Dr. **Weinberger.** I will be happy to do that.

Mr. **Fulton.** Thank you.

(The information requested is as follows:)

The Water Quality Act of 1965, which amended the Federal Water Pollution Control Act to provide for the establishment of water quality standards for interstate waters or portions thereof and to make the discharge of matter which reduces the quality of such waters below the water quality standards established under the Act subject to abatement, specifically provides that "nothing in this subsection (Section 10(c) of the basic Act as thus amended) shall . . . extend Federal jurisdiction over water not otherwise authorized by this Act." The basic Act was amended by the Federal Water Pollution Control Act Amendments of 1961 to make the pollution of navigable waters, as well as interstate waters, which endangers the health or welfare of persons, subject to the Act's abatement authority.

The Act does not confer, not would we expect to exercise, arbitrary power to outlaw an industry as socially or economically undesirable. Its provisions respecting the establishment and implementation of water quality standards, and the abatement of pollution, are set about with safeguards against unreasonable action.

Mr. DADDARIO. There is no question, however, in your mind, Dr. Weinberger, but that these problems do affect the environment of this country. We do find a relationship to ocean currents and to climatic streams which can cause problems in places throughout the world. One has an effect on the other. It is simply a challenge to our laws to adjust ourselves so that we can overcome those problems and not allow ourselves to deteriorate because we place artificial barriers in front of the accomplishment of this end objective.

Dr. WEINBERGER. I do not think there is any question. I did not mean not to be directly responsive to Mr. Fulton, but there is jurisdiction, of course, so far as the effect of the activities in one State as they affect another, and many of the States in terms of the existing water quality standards have to themselves make some of the decisions Mr. Fulton is raising.

Mr. DADDARIO. We are coming into an entirely new set of nationwide and world conditions. Because we recognize that they will cause trouble, we are beginning to adjust ourselves in order to handle them. I can see where we are going to have difficulty, but certainly is not an impossible barrier.

Dr. WEINBERGER. No, sir. We, of course, on even the international phase, already have agreements as far as disposal of radioactive waste.

Mr. FULTON. Do you have the right in terms of Federal jurisdiction to ban coal mining in Pennsylvania because sulfuric waste causes pollution of the Lower Mississippi and colors the cotton grown by Mississippi?

Would you have the power to prevent the cotton from being colored, and therefore not salable, by the sulfur waste clear up in the Allegheny and Monongahela?

Dr. WEINBERGER. We will develop that for the record.

Mr. FULTON. Could you put a yes or no on that and we will go on?

Mr. DADDARIO. I would like to simply say again in this particular area, I do not know that it calls for a yes or no answer or that any Government agency has the power to do this. Rather, we as a society somehow must come up with a determination so that these derogatory or disastrous effects do not occur. Within the framework of our present free enterprise system we will make determinations which will overcome these problems because we must. It does not mean that the Federal Government will have the power. There is a whole wide stream of ramifications within which we can work.

Mr. FULTON. We may need a constitutional amendment to give the power to either the Federal Government, the States, or the local municipalities to proceed on this broad basis as a national policy for our U.S. resources.

Mr. DADDARIO. Dr. Weinberger, does not the general welfare clause, presently one of the foundation of our Constitution, give us a great deal of leeway in this particular area?

Dr. WEINBERGER. The Federal Water Pollution Control Administration at the present time does have and has exercised a certain amount of power in terms of protecting the welfare and well-being of our citizens.

Mr. FULTON. My point is, where does that power end or how far does it extend in jurisdiction? I must say you are well represented by the chairman here.

Mr. **Daddario.** I am not trying to represent Dr. Weinberger. I am trying to represent my own ideas. This is not a matter in which the Federal Government alone is involved, and the solution of these problems does not come from the power of the Federal Government. Rather, it comes from the hopes and ambitions of our society. I think it is important that we, as a subcommittee, view these proceedings with objectivity and flexibility of mind. It is one of the basic criteria by which we must act.

Will you proceed, Dr. Weinberger?

Dr. **Weinberger.** I mentioned that the assistance of industry in the form of ideas, processes, products, and services will undoubtedly hasten the solution to some of the Nation's industrial pollution problems. Industry, for purposes of our R. & D., may be classified as follows:

1. Industries having a pollution problem.
2. Industries who have or expect to develop a commercial position in pollution control equipment, chemicals, instrumentation, processes, systems, or services.
3. Industries having a research and development capacity which has not been directed to pollution control.
4. Combinations of the above.

I would like to point out some of the factors which industry considers in participating in a federally supported research and demonstration effort.

There are a number of positive factors as far as industry is concerned and those are:

The fees associated with the contract.

The experience gained by their personnel.

The advances they may make in their technological position.

The publicity associated with contract awards.

The fact that financial risk is minimized.

An earlier demonstration of efficacy of results thereby establishing markets.

The negative factors that industry looks at are:

The time and effort of proposal preparation.

The time and effort of proposal negotiation.

The diversion of their competent personnel from other research and development activities.

Personnel who have gained experience at company expense working on a federally supported project would produce results available to competitors.

The contractor's art may be disclosed earlier than usual to competitors.

A noncontracting competitor can improve his competitive position with a minimum of contribution and a minimum of risk.

And, of course, any unfavorable publicity resulting from negative results.

By negative results, I do not mean poor research; I mean if the results do not come up with an improved solution.

Mr. **Daddario.** Dr. Weinberger, without our getting into an interminable discussion on the patent situation, under which of these sides do you put Government patent policy in relationship to industry. Is it positive or negative, and under which of those subheadings?

Dr. **Weinberger.** I would say from the viewpoint of many of the industries I have talked with, it would be on the negative side. I might say that the patent policy——

Mr. **Daddario.** Then you would add another category to the negative side?

Dr. **Weinberger.** Yes, sir. This patent would be covered really in terms of the fact of disclosure of work being carried out, the rights to patents and the background patents which are all bound up in our patent policy.

Mr. **Daddario.** Let's not get into that.

Dr. **Weinberger.** On a number of other occasions I have mentioned the importance of demonstration and field evaluation. As a matter of fact, I believe I mentioned that when I appeared before this committee last time.

The Clean Water Restoration Act passed by the Congress in 1966 amended the Federal Water Pollution Control Act and makes it now possible for us to support large-scale field evaluation and demonstration projects. This program is approximately 1 year old but there is already ample evidence to indicate that the most significant contribution to the solution of water pollution by the development and application of new and improved technology will result from this program.

I have made available copies to the members of the committee of all of the grants we have made in this program for your review.

I would like to just quote something from an annual report that came to my attention just last week. This is the Pulp Manufacturers Research League, who in their 1967 annual report made the following references to grant support which they received from the Federal Water Pollution Control Administration:

> A fair estimate is that this League-Federal project will move ahead by as much as five years the time when pulp and paper mills will have a solid dollars and cents foundation upon which to base a yes or no decision for reverse osmosis. If this in-plant process proves as sound financially as it is already proved technically, the industry will have an effective and economical method for treating dilute effluents to a previously unattainable level of purity.

Mr. **Daddario.** Do you assume that a previously unattainable level of purity, which does not mean absoluately pure, is going to fall within criteria of purity which will satisfy you?

Dr. **Weinberger.** Yes, sir. I might comment on that because one of the approaches being taken by this particular project in so many other of our grants is leading to a recycle of water. If successful, many installations will have no liquid waste discharge by recovering the impurities and simply recycling the water, thereby perhaps having no liquide discharge or a minimal discharge.

Mr. **Ryan.** Do you anticipate that that process will be applicable, and, if so, when, to municipal sewage waste?

Mr. **Daddario.** If it is applicable.

Dr. **Weinberger.** Yes; if it is. I would say that the work on the applicability of reverse osmosis to municipal waste, although it is under intensive study by our program, and these are listed in a number of locations, the need to accomplish the desired results is not as pressing for municipal waste—let me rephrase that. We have some alternate ways of accomplishing removal for municipal waste which show as of today more economic promise than reverse osmosis in a municipal plant installation.

Mr. DADDARIO. Proceed, Doctor.

Dr. WEINBERGER. Again referring back to figure 1, which indicates our total R. & D. effort, I would just like to mention some of the problems that stand out as being extremely high-priority items. These include municipal waste treatment, industrial waste treatment and control, improved methods for measuring effective pollutants, that is, water quality requirements including temperature effects, the disposal of impurities or solids removed from waste, mine drainage, irrigation return flows, agricultural land runoffs, storm and combined sewer discharges and lake, estuary, and ocean disposal of treated and untreated wastes.

I have discussed previously the problem of treatment and we have ample evidence to indicate that we can indeed treat waste waters to provide water of better quality than we started with. However, I would like to illustrate some additional areas of research and development that might be considered just under the subcategory of municipal pollution control. Some of these we have already talked about in my responding to questions.

One, improved procedures to accomplish more effective operation of plants; two, methods for increasing the capacity and performance of existing plants; three, improved design and construction procedure, including materials of construction.

Gentlemen, the biggest cost in pollution control is going to be in construction dollars and any improvements that we can make in reducing costs can significantly reduce our overall bill.

Work on design of treatment plants which would occupy a minimum of land area. Land is becoming more valuable, more critical. We have to consider design where land is used more effectively.

New systems for combining the waste water purification steps of the water cycle and perhaps a little bit into the future treatment systems which would result in valuable byproducts.

Mr. RYAN. Before we leave page 17, I would like to raise several questions regarding the treatment of municipal waste and specifically ask what level of treatment is attainable—let me ask that in terms of removal of waste—from municipal sewage.

Dr. WEINBERGER. Mr. Ryan, technology is available today for the removal of virtually all of the impurities which are introduced into our water resulting from municipal use of that water. In one of the summary sheets which I have, reference is made to a plant which is in operation in Tahoe on the Nevada-California border where extremely high degrees of removal are being accomplished. This is not very commonly employed, but I think Mr. Ryan asked what could be done. This is what can be done.

Mr. RYAN. What percentage is being removed in Lake Tahoe?

Dr. WEINBERGER. In Lake Tahoe there is better than 99-percent removal of the organic material. When I say better than 99 rather than 100 percent, our analytical techniques are inadequate in some of these cases to analyze all of the suspended material. Removal of such things as phosphates in excess of 90 percent, virtually complete bacterial destruction. And I would be very happy to submit to the committee a specific breakdown on the results of that plant's operation, sir.

Mr. **Ryan**. And the costs?

Dr. **Weinberger**. May I supply that, Mr. Ryan? I do not have them with me right now.

Mr. **Ryan**. Yes.

(The information referred to is as follows:)

Lake Tahoe Water Reclamation Plant, Operation

Element:	*Removal (percent)*
BOD, mg./l	>99
COD, mg./l	>95
Phosphate, mg./l as PO_4	>99
ABS, mg./l	>90
Nitrogen	
Organic N, mg./l. as N	>95
Ammonia N, mg./l. as N, approximately	95
Calcium, mg./l. as Ca	Small increases due to the addition of lime.
Alkalinity, mg./l. as $CaCo_3$	
Sulfate	

COSTS

[Dollars per million gallons]

	Capital	Operating	Total
Lime treatment for phosphate removal	11	52	63
Ammonia stripping (95 percent removal)	6	9	15
Filtration	17	24	41
Carbon adsorption	18	12	30
Total	52	97	149

Note: Costs include phosphate, nitrogen, and organic removal plus recovery and reuse of lime and carbon.

Mr. **Ryan**. Let me ask you a question.

Last September there was a second session of the Conference on the Pollution of Interstate Waters of the Hudson River and Its Tributaries, and one of the recommendations and conclusions of that conference was that all waste prior to discharge into the waters covered by the conference should be treated to provide a minimum of 80 percent reduction of biochemical oxygen at all times.

Do you regard that as an unreasonable conclusion or recommendation?

Dr. **Weinberger**. I am hesitating, Mr. Ryan, in trying to respond correctly to your question. From a technical point of view, it is something which we can quite reasonably achieve. I do not have any question concerning whether we can achieve an 80-percent removal. I am not sure whether this is what Mr. Ryan is asking.

Mr. **Ryan**. Yes. I asked whether you considered the recommendation of the conference something reasonable from a technical point of view. Is it achievable?

Dr. **Weinberger**. Yes, sir; from a technical point of view it is certainly achievable.

Mr. **Ryan**. With today's technology?

Dr. **Weinberger**. Yes.

Mr. **Ryan.** It goes on to say:

> It is recognized that this will require design for an average removal of 90 percent of biochemical oxygen demand.

Is that a fair statement of the case?

Dr. **Weinberger.** Yes, sir.

Mr. **Ryan.** In other words, to achieve 80 percent reduction it is necessary to design a plant for 90 percent removal?

Dr. **Weinberger.** To make sure we are always getting 80 percent. There are fluctuations in terms of the strength of the waste coming through a plant; there are operational variations. If we want to make sure that we get at least 80 percent, since there will be a fluctuation sometime, we will achieve 95 percent and other times it will be 85 and it could get down as low as 80 percent.

Mr. **Ryan.** Are there cases where the recommendations that have been made were higher than 80 percent minimum reduction?

Dr. **Weinberger.** Yes, sir.

Mr. **Ryan.** Where?

Dr. **Weinberger.** I would be pleased to get a copy of that for you, sir. I know this has been done. If I may, I will supply it for you.

(The information requested is as follows:)

DEPARTMENT OF THE INTERIOR FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

HIGHER THAN 80 PERCENT BOD REDUCTION

Recommendations requiring higher than 80 percent reduction of biochemical oxygen demand are included in agreements reached by the Federal-State conferees in the following actions:

1. Penobscot River and Upper Penobscot Bay (Maine)

Recommendation

8. The abatement programs for the two poultry companies, Maplewood Packing Company and Penobscot Poultry, will be based on a 90% reduction of biochemical oxygen demand (BOD), 90% reduction of solids, and an effluent not to exceed 5,000 coliforms per 100 ml.

2. Moriches Bay and the Eastern Section of Great South Bay (Long Island. New York)

Recommendation

7. All the duck farms in the conference area:

(a) On or before August 1, 1967, shall submit to the New York State Department of Health final construction plans in approvable form, prepared by or under the direction of a duly licensed professional engineer, for adequate waste treatment facilities to remove at least 85 percent of the suspended solids and at least 85 percent of the biochemical oxygen demand, and a substantial portion of the phosphates thereof and therein shall be removed, and facilities for disinfecting such wastes and/or waste effluents to the extent that the final effluent shall at all times contain the chlorine residual of not less than 1 ppm after not less than 15 minutes contact time and a coliform count not greater than 100 per 100 ml in at least 90 percent of the samples in a series thereof, provided that at no time the coliform count of such organisms in said final effluents exceed 10,000 per 100 ml.

(b) On or before November 1, 1967, initiate construction of such facilities.

(c) On or before April 30, 1968, complete construction of such facilities.

(d) Thereafter maintain and operate such facilities in such manner that they at all times meet the performance criteria set forth above, and that the persons responsible for the maintenance and operation of such facilities set up an adequate trained and equipped staff in order thereafter to maintain and operate treatment facilities installed at duck farms at all times in conformance with requirements established by the New York State Department of Health.

3. Eastern New Jersey from Shark River to Cape May (New Jersey)

Recommendation

9. The New Jersey State Department of Health has adopted water quality standards for the waters of the conference area and has submitted the standards to the Secretary of the Interior for approval as Federal water quality standards under the provisions of section 10 of the Federal Water Pollution Control Act, as amended. These standards require that all wastes discharged to the Atlantic Ocean receive, as a minimum, treatment that will provide at all times 85 percent removal of BOD, and that all wastes discharged to the estuaries or tributary streams receive a minimum treatment at all times of 95 percent removal of BOD.

Mr. RYAN. In light of the conference recommendation for an 80-percent minimum reduction, and therefore design removal of 90 percent, is it consistent for New York City to propose a plant today with today's technology available which will achieve only a 70-percent removal at design capacity?

Dr. WEINBERGER. Mr. Ryan, that decision would not be based on let's say our technical ability to achieve greater removal. I am not familiar with all of the circumstances concerning what action New York State or New York City may have taken, but certainly the decision could not be on a basis of our technical ability to remove more than 70 percent or 80 percent of the impurities.

Mr. RYAN. New York City apparently intends to go ahead and construct a new plant which is designed to remove not 90 percent but 70 percent when construction is completed. But, as I understand it, that will go down to some 53 percent within a few years. How is this justifiable?

Dr. WEINBERGER. I can conjecture or surmise; but, if I may, I would much prefer to give you a written statement after I have had an opportunity to review this. I would again just make this one point: In the usual practice that we have today, when treatment plants are built they are frequently built on a stage basis. The first step in the design would be referred to as a primary treatment plant which might only remove 40 or 50 percent of the pollution load. On to that plant may be added, which is frequently done, a second-stage plant which can remove all the way from the 40 percent up to the 90 or 90-plus percent.

And in addition to that, when occasion arises, we can add a third step which is essentially what they have done at this place in Tahoe I referred to, where they have added on additional facilities to an existing plant. So that this may be one of the factors, but I will look into it and give you a reply.

Mr. RYAN. The fact is the 70 percent includes secondary treatment. It is not through primary treatment. It is through secondary treatment.

Dr. WEINBERGER. It sounds as if it would be some sort of accelerated treatment that would be intermediate between the primary removal and what could be accomplished by actual utilization of secondary capacity.

Mr. DADDARIO. It would appear wise, Mr. Ryan, if we were to allow Dr. Weinberger the opportunity to answer that question for the record so it could be more definite and precise.

(The information requested is as follows:)

Justification for the construction of a waste treatment plant constructed in New York City which will remove not 80 percent, but 70 percent when construction is completed, with the posibility of design capacity to decrease to 53 percent within a few years.

We understand this question refers to the North River treatment plant, which is expected to provide approximately 70 percent reduction of biochemical oxygen

demand (BOD) at present loading levels. This plant does not meet the recommendations of the water quality standards approved by Secretary Udall for New York's interstate waters or the Federal Enforcement Conference on the Hudson River. However, there are a number of reasons why construction of this facility is warranted.

The facility provides a resonably high level of treatment which will result in water quality enhancement. The plant was designed and land acquired prior to the effective dates of the Federal water quality standards and Federal Enforcement Conference recommendations, which specified higher levels of treatment than attainable at the North River facility under its present design and scope. Although this plant will not meet standards and conference requirements, it will be removing 70 percent of the biochemical oxygen demand of wastes, amounting to millions of gallons per day, which would otherwise be discharged raw to the river.

The facility will be part of a proposed system which, by the conference and standards deadline of 1972, should be providing treatment substantially in accordance with the standards and conference recommendations. The basic problem at this time is one of space on which to build a complete treatment facility which would remove 80 percent BOD at all times. The North River plant is designed to achieve as much treatment as possible within space and time limitations. The City of New York has recently acquired an additional 2.8 acres of land adjacent to the North River plant site on which to construct additional treatment facilities which will remove 70 percent BOD at design capacity (some twenty-five years hence), but which in earlier years of operation will achieve substantially greater treatment. Further, the City of New York has initiated the necessary administrative proceedings to acquire 4.9 acres of land for the purpose of constructing additional treatment facilities designed for 90 percent BOD removal to meet the Hudson River Conference recommendations and the water quality standards approved by the Secretary. The progress of the City in this regard will be regularly reviewed by the enforcement conferees, and every effort will be made to assure that the City meets the 1972 deadline.

Delay in constructing the treatment plant will result in increased cost to the City, the State and the Federal Government. Construction costs in New York City are increasing about 8 percent annually. Any delay in construction of the proposed treatmet plant will result in substantially increased costs to the City, New York State and the Federal Government. The North River project for both intercepter sewers and waste treatment plant has a present estimated cost of about $180,000,000, Each year's delay in going ahead with the project, whether caused by redesign or relocation, imposes an additional cost of about $15,000,000. Total redesign to upgrade the treatment levels of the North River plant would entail at least a three-year delay; the delay alone would cost $50,000,000.

Mr. RYAN. May I ask this question: What is the difference in the water quality which results from 90-percent removal compared to 70-percent removal, or 80 percent compared to 53 percent?

Dr. WEINBERGER. Let me try to answer that as briefly as possible. If we consider the 90 percent removal as contrasted with let's say 60 percent removal, then we would be introducing only one-fourth of the amount of impurities into the receiving stream. I am referring to what we would be discharging into the stream.

What effect this has on the stream would depend on the volume in the stream as well as the various use that stream is being protected for.

Mr. RYAN. Do you want to proceed or should we go into this further, Mr. Chairman?

Mr. DADDARIO. Mr. Ryan, you proceed until you are satisfied.

Mr. RYAN. I would like to come back to the question of the inconsistency of the Hudson River Conference recommending 80 percent reduction. Are you familiar with the New York State standards that have been approved by the Federal Government?

Dr. WEINBERGER. No, sir; I do not know whether that is one of the 15 that have been approved or not.

Mr. **Daddario**. Provide that for the record.

Dr. **Weinberger**. I will be happy to.

Mr. **Ryan**. Simply the inconsistency between the conference recommendation, which apparently is low compared to the state of technology anyway, and the initiation of a plant which would achieve at best 70 percent, and, according to my information, would go down to 53 percent in the next few years.

Dr. **Weinberger**. Mr. Ryan, I will be happy to go into that and, as I say, I think there are two different factors. That is why I hesitated originally in responding to your question. There is a question of available technology, I think, and the second question then is, In any particular installation, what is the required treatment to achieve your objective?

So when you asked the question initially, What is the best degree of treatment we can have? And I indicated it is substantially a complete removal of all impurities, we have not reached the point where this is being recommended for each and every community in the United States. So at the present time, one finds recommendations which provide for treatment facilities which do not necessarily remove all of the impurities that we can.

Do I make that clear?

Mr. **Ryan**. That is the difference between complete and 80 percent. We are now talking of the difference between complete and 70 percent going down to 53 percent.

Dr. **Weinberger**. In terms of the individual situation, and I will look into that.

(The information requested is as follows:)

DEPARTMENT OF THE INTERIOR FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

Have water quality standards been approved by the Federal Government for the State of New York? What is the relationship between the Hudson River conference recommendation of 80 percent removal and the water quality standards as approved by the Federal Government in New York State?

Water quality standards have been approved by Secretary Udall for the interstate waters of New York under the Federal Water Pollution Control Act, as amended. These standards, which are presently being implemented by the State of New York, provide for a minimum of secondary treatment or the equivalent for all municipal and industrial discharges. "Secondary treatment" is generally defined by water pollution control officials as ranging from about 75 percent to about 95 percent reduction in biochemical oxygen demand.

The water quality standards anticipated reconvening of the Hudson River Enforcement Conference, A letter of August 4, 1967, from Dwight F. Metzler, Deputy Commissioner of the New York Department of Health, was included in the standards affirming the State's intent to implement the recommendations of all Federal enforcement conferences of which it had been a part, and indicating that the State would ". . . carry out its responsibilities as a conferee at the re-opening of conferences in the formulation, endorsement, or modification of the conclusions and recommendations of such conferences."

Cognizance of water quality standards was taken by the conferees at the second session of the Hudson River Enforcement Conference, and the recommendation in question reads:

> All wastes prior to discharge into the waters covered by the conference (a) shall be treated to provide a minimum of 80% reduction of biochemical oxygen demand at all times. It is recognized that this will require a design for an average removal of 90% of biochemical oxygen demand. *Or* (b) shall be treated, as approved by the State water pollution control agency, to the degree necessary to meet the water quality standards approved by the

> Secretary of the Interior under the Water Quality Act of 1965. [Italics added.]
>
> New York is implementing the treatment requirements called for in the water quality standards as necessary to protect the beneficial water uses and meet the water quality criteria. These requirements provide for significant enhancement of presently polluted waters. Where these requirements are below the 80 to 90 percent BOD reduction level, New York indicates that the affected treatmen facilities will be required to upgrade to this level as a second stage in the implementation program.

Mr. DADDARIO. When Dr. Weinberger answers your original question, Mr. Ryan, it appears that others such as this you are working on now will come. We will see to it, when the answer is submitted, our staffs do get together, and you will have an opportunity to ask additional questions so we can resolve this question.

Mr. RYAN. Thank you.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. I would like to make an observation or two and ask some questions.

For one thing, as far as the technology of water treatment is concerned, I think we are putting undue emphasis perhaps on the technology and not enough emphasis upon the economics. It seems to me the matter is primarily one of economics. Water treatment is probably one of the very few areas where we have had the technology since the invention of fire to produce practically pure water; namely, by evaporation. The question is whether we have the need and the resources to produce pure water in every situation.

I think undoubtedly the situation in New York to provide an additional level of purity beyond what they have apparently scheduled would require probably substantial capital investment and operating costs. The real problem is how much capital investment and operating costs are you willing to put up in order to secure a given degree of purity of water? I think these are the questions that need to be answered, basically, in connection with any discussion of water treatment.

The question I have is really a rather general one based upon an article I read within the last few weeks. I am not even sure where I read it. It was a discussion of a visit of a group of Americans to Russia and a trip down the Volga River. Having an interest in water pollution, I was struck by the fact that the article commented several times that the Volga was a relatively clean river, that they were able to swim in it, that the fishing resources were apparently as great as they ever had been, and that local sewage, what I guess would be municipal and industrial waste, was not permitted into the river.

Is it possible that in Russia and perhaps in other long-developed European countries they have achieved practices which are substantially superior to what we have here in the United States at this time in this field?

Dr. WEINBERGER. Mr. Brown, I have not seen this from personal visits to Western Europe. I think at the present time in most areas of water pollution control, our technology is further advanced than those countries and I think this is explainable due to World War II, when so much of their activity ceased. This is not to imply they would not be making additional contributions. But I do not know of any technology that has been developed or applied or under study in any part of the world that we have not looked at or are looking at.

Mr. **Brown**. Would this necessarily be a question of advanced technology? Could it be just a simple matter of prohibiting industrial and municipal waste going into rivers as in the case of the Volga?

I do not know where it would go, but perhaps into the underground basin in some fashion which would preserve the purity of the river and ultimately it perhaps would pollute the land; I do not know. But it does not necessarily have to be a technology problem. It would be a standards problem.

Dr. **Weinberger**. I think it is also a matter of institutional arrangements. I think we get back to perhaps some of the points Mr. Fulton was raising in terms of the management of the waste, management of industry, management of location, the whole decision process of what you permit people to do and not do. There are some management practices, institutional arrangements in parts of Europe which we have looked at and, as you gentlemen are probably aware, the Ruhr and Emscher river systems have been extensively looked at because of the way in which the Germans manage those two rivers.

Mr. Brown. Do you know anything about the conditions of the Rhine? Is it a comparable situation to, say, the Hudson or something of that sort?

Dr. **Weinberger**. My simple answer would be to say the Rhine is polluted. I do not think we could make a comparison to the Hudson. I happen to think there are some parts of the Hudson which are much prettier than the Rhine and in better shape than the Rhine. On the other hand, one could say there are some parts of the Hudson that are more polluted than parts of the Rhine. But the Rhine is basically a polluted river.

Mr. **Brown**. I think one of the general points I want to arrive at is the degree to which we are considering in our development in water pollution control the standards and achievements which have been reached in the rest of the developed world. Is this an input into our study? Do we have good comparative studies of what is going on in these other countries in terms of results as well as technology?

Dr. **Weinberger**. Reasonably well, Mr. Brown. I say reasonably well. This gets into our problem of information exchange. But we have a number of bilateral and multilateral agreements whereby we are able to get this information.

Mr. **Brown**. There could be some very sound political reasons to get this. You know about 95 percent of our R. & D. money is justified on the grounds of a gap between us and the Russians. If you could show us a pollution gap, for example, you might be able to justify a very large increase in funds for the program. I have no further questions.

Mr. **Daddario**. Dr. Weinberger, is it not difficult to come to some assessment about all of this? As I understand it, our staff did some work in investigating some of these places. We think others are doing better than we are doing, and they think we are doing a lot better than they are doing.

You take the Rhine. It is polluted, as you say, but less polluted than people expect it to be. The reason for this is that they allow other rivers in the area to be more polluted and in that way take some of the strain off the Rhine. Therefore, they are shifting the problems around. In the final analysis, their situation is probably worse than ours.

Dr. **Weinberger**. Yes. They have one situation over there which has been looked into, studied, quoted, reported on, which is the situation involving the Emscher Cooperative. A solution is being applied there which I seriously question would be considered an acceptable solution in the United States. What they have done over there is, they have taken one river, the Emscher River, and have earmarked this as an open sewer. As a matter of fact, in talking to the engineering manager of that association, he has no hestitation in calling that a sewer rather than a river. And it is essentially the setting aside of one river to collect the waste for a particular watershed, trying to protect the Ruhr River in this case from pollution. And what they have done is, they have taken the entire river before it goes into the Rhine and put it through a treatment plant.

I do not think this is an acceptable solution in the United States. I have difficulty in picturing parts of our Nation being willing to have a river going by them which would be an open sewer. But again, this is an institutional arrangement that has been made over there.

Mr. **Brown**. We would put it underground probably over here.

Mr. **Fulton**. Mr. Chairman?

Mr. **Daddario**. Yes.

Mr. **Fulton**. In Pennsylvania we have found that using underground mine passages and crevices as sewage sinks does not work and so we have proceeded to outlaw that practice.

Has there ever been a survey, Doctor, of how much the Federal Government is conforming to its good principles on the disposal of its waste and sewage?

I will give you a good example. Our big Federal building in Pittsburgh was being charged for our new sewage disposal system so much a month for disposal of waste. After paying it for a while, the Federal Government came back and said to the local people and the sewage authority in Pittsburgh: We are not going to pay it any more. The question was why? They said: Well, we, the U.S. Government, are not using the sewage disposal system of Pittsburgh, we are dumping it directly in the river. So the big Federal building was the biggest pollutant in our town.

Has it been cured now?

Dr. **Weinberger**. There is a very intensive and strong effort on the part of the executive branch to make sure that pollution from all Federal installations is brought under control.

Mr. **Fulton**. With the Chairman's permission, could you put a statement on it in the record?

Dr. **Weinberger**. We will be happy to do that.

(Information requested is as follows:)

CONTROL OF POLLUTION BY FEDERAL ACTIVITIES

To date, the fifty-eight volume publication, *Wastewater Disposal Practices at Federal Installations*, is the only comprehensive inventory of the wastes discharged into ground or surface waters from Federal activities. Published in 1962, this study was conducted by the Public Health Service, Division of Water Supply and Pollution Control (now the Federal Water Pollution Control Administration) and the General Services Administration. It reports conditions as of December 31, 1960.

While this study reports on sewage and industrial wastes (excluding cooling water), both waterborne and non-waterborne, discharged at 22,656 points, it does not contain an exact count of the number of installations actually reported upon. The majority of installations included in the 1960 study reported two or more points of discharge for the wastes generated. Educated estimates place the number of installations covered between 7,000 and 8,000. In general, the scope of the report excluded those installations at which there was no activity which would be expected to generate a waste discharged to ground or surface waters. The 1960 study reported discharges of both adequately treated and inadequately or untreated wastes.

The Natural Resources Subcommittee of the Committee on Government Operations, House of Representatives, used the 1960 study as the basis of its 1964 and 1965 surveys of sewage and industrial waste disposal at Federal installations. (Copies of the reports of the surveys, House Report 1636, 88th Congress, 2nd Session; House Report 555, 89th Congress, 1st Session; and House Report 1644, 89th Congress, 2nd Session, are submitted for the information of the Committee.) For these reports, the committee selected from the 1960 study a total of 1,003 Federal installations that discharged waterbone sewage or industrial wastes (excluding cooling waters) "at a rate of 3,000 or more gallons per day, or non-waterborne wastes of 200 or more persons per day" or which had "received a notification from a Government agency that a pollution condition exists."

President Johnson, in 1965, issued an executive order, the strongest executive statement to date on the water pollution control responsibilities of Federal agencies, which became the basic policy of the entire Federal Government. The Executive Order, as superseded in 1966 by Executive Order 11288, requires the heads of Federal departments, agencies, and establishments to provide the leadership example in the national water pollution control effort. It requires the Secretary of the Interior to provide the necessary review, coordination, and technical advice and assistance to Federal agency heads, who are in turn, directed by Section 11 of the Federal Water Pollution Control Act to cooperate with the Secretary, and with State and interstate, and municipal agencies. In addition, the Order establishes general standards and procedures to facilitate Federal agency budgeting for water pollution control measures.

Program responsibility for the Secretary's functions is vested in the Federal Water Pollution Control Administration, whose Regional Offices have primary operating responsibility within their respective regions. FWPCA's responsibilities under Section 11 of the Act and the Executive Order include: assisting Federal agencies to clean up pollution from their facilities; reviewing proposed Federal water resources projects to determine their impact on water quality; helping other Federal agencies to include water pollution control standards in their loan, grant, and contract practices; and assisting other agencies to prevent pollution from Federal vessels.

To facilitate interagency cooperation and to provide a framework for coordination between Federal and non-Federal agencies, FWPCA has issued "Guidelines for the Prevention, Control, and Abatement of Water Pollution from Federal Activities," (copy submitted for the Committee's information). Through its programs of review and technical assistance, FWPCA has helped to develop water pollution control programs at Government military bases, hospitals, national parks, and forests, post offices, and Federal water resources development projects. Agreements on program procedures have been reached with the Forest Service, the Bureau of Public Roads, and the Corps of Engineers. Similar understandings are being worked out with the National Park Service, Bureau of Indian Affairs, Bureau of Outdoor Recreation, and the Department of Defense.

FWPCA has reviewed plans from 16 agencies for improving water pollution control at Federal installation. As a result of priorities recommended to the Bureau of the Budget, the FY 1968 Federal Budget included requests for $51 million to upgrade water pollution control at Federal installations.

The almost unlimited activities pursued under Federal loans, grants, and contracts offer a particularly significant means of exercising Federal leadership in this area. Section 7 of the Executive Order encourages all Federal agencies to include water pollution control standards in their loans, grants, and contracts. FWPCA has reviewed reports from 21 other Federal agencies detailing to what extent their loan, grant, and contract procedures should include such standards.

A Departmental Task Force has comprehensively reviewed the loan, grant, and contract practices of Interior and other agencies, and will propose pollution control requirements that could be made applicable to borrowers, grantees, and contractors. In addition, the Department has informed all its constituent agencies that Interior is expected to set an example in this government-wide effort. The agencies have been directed to submit for FWPCA review all proposed regulations for water pollution control. This would apply to leases, licenses, and permits issued by the Department of the Interior as well as loans, grants, and contracts.

Current plans now call for control of pollution from all existing Federal installations within five years.

Mr. **Fulton**. The other point is on the historic use of certain waters. What effect does the historic use of waters have on the clearing up of pollution and waste? For example, on the Musatox you might have a person who would rather have birds, bees, or flowers. To what limits of the historic water doctrine are we bound because some areas may now be industrial with certain customary results of the industrial use of the water?

Dr. **Weinberger**. I will supply that for the record.

(The information requested is as follows:)

The Federal Water Pollution Control Act, in Section 10(a), makes the pollution of interstate or navigable waters, which endangers the health or welfare of any persons, subject to abatement. The historic use of any such waters for a certain purpose or purposes does not as a consequence convey any prescriptive right to pollute. Pollution resulting from the established use of such waters, which endangers the health or welfare of any persons, is fully subject to the abatement authority conferred by the Act.

Mr. **Daddario**. We are running a little behind time so we better speed things up.

Dr. **Weinberger**. Let me just conclude my presentation by referring to figures 2 and 3 which I think are the two most important figures to explain the scientific and technical basis for controlling water pollution.

Figure 2 (p. 194) which is labeled "Effects on Water Use by Pollutants" indicates that for any water pollutant that has an adverse effect on any water use, it is one probably of function of the time of exposure.

Let me consider for a moment and use for example a toxic material. We will consider a metal, copper, and its effect on fish.

The concentration in the water and the time that the fish is exposed to that concentration will produce certain effects. If the level is low enough it may produce no effect. If it is too high, and this would be to the right of the figure, there would be death of the fish. Between no effect and the death, there would be various other detrimental effects, including such things as the inhibition of reproduction, the fish may not be as large, it may actually result in certain behavioral aberrations. These can become quite important if the fish is unable to compete for food.

One of the major research efforts that we have underway is to determine the relationship between specific impurities under various water users. This will end up with a series of curves as illustrated by figure 2.

We must do this, not only for each individual pollutant but for combinations of pollutants. For example, again speaking of fish, and fish turn out to be a much better animal to do research with than man, there is the relationship between a heavy metal and let's say a pesticide or the thermal effects or any other impurity or pollutant going into our stream. But, nonetheless, through research and development we are trying to obtain this kind of information, and we must obtain this information, which indicates the relationship between concentration and effect for various water use. These water uses will be not only for fish but for municipal purposes, industrial purposes, and agricultural purposes.

Figure 2 represents what concentrations you should have in order to protect a particular water use.

Referring to figure 3 (p. 195), it indicates what we are trying to accomplish through our waste treatment or control technology program.

Figure 3 indicates that cost to achieve final concentrations in waste treatment or through control.

What this chart indicates is that knowing your initial concentration in waste, what would it cost to treat, or using other methods of control, to reduce that concentration to any level.

With the information available from figure 2 and figure 3, the Administrator having responsibility for establishing water quality standards will be in a position of knowing what kind of water he must have to protect that water use and what it will cost him to accomplish that.

I would say there our entire research effort can be almost summarized by getting those two sets of answers. I might say there is one category that is extremely important, touched on very briefly. That would be research into socioeconomic bases, the policy-science basis for enabling the Administrator to take the scientific and technical information we have developed in figures 2 and 3 and make his decision as to what water use we are going to have in any particular location.

Mr. **Fulton**. Mr. Chairman?

Mr. **Daddario**. Yes.

Mr. **Fulton**. One of the chief pollutants is the detergents, cleaners, or soap mixtures of various kinds. What do you do to prevent this before you get this tremendous perpendicular column of heavy pollutants? Are you doing anything there?

Do you say to the manufacturer you cannot make this kind of a detergent because we know it is going to pollute the streams? What do you do then?

Dr. **Weinberger**. We do not have any legislative authority which would enable us to prohibit any manufacturer from manufacturing a product. However, we have called it to the attention of manufacturers when their products may cause a pollution problem.

The detergent industry about 3 years ago had brought to their attention that the type of detergent they were formulating was causing pollutional problems, that it would be very desirable if they had or were able to come up with a substitute product.

There was legislation introduced in the Congress. Before that legislation was enacted, industry voluntarily converted from one from of detergent to another, primarily for the purpose of reducing its pollutional impact.

Mr. **Fulton**. Is the present type of detergent a pollutant?

Dr. **Weinberger**. If the present type of detergent went into a river without treatment it would be a pollutant.

Mr. **Fulton**. Would it be feasible to put a tax on pollutants so that when the person buys the can of detergent he likewise pays for the cost of cleaning it up. What do you think of that?

Dr. **Weinberger**. This is certainly a possibility and one of the things that ought to be looked into in terms of meeting our overall cost and ways of accomplishing pollution control. It is an alternative.

Mr. **Fulton**. By putting the tax on the product that is going to cause the pollution, you then have a readymade antipollutant to clean it up.

Dr. **Weinberger**. I can see some difficulties, Mr. Fulton, because almost everything that we buy and everything that we use ends up being a pollutant. The food that we buy.

Mr. **Fulton**. You can certainly tax detergents and not food.

Dr. **Weinberger**. This is one of the problems in terms of what one——

Mr. **Fulton**. With that approach, the question is on what you can do with handling milk or beer. You can do a lot more things with beer through the governmental approaches, or on cigarettes, that you can not do with milk.

If we could pick some products that were known to be pollutants, or manufacturing processes that cause extreme pollution, why not tax them? The more the pollutant the bigger the tax.

Dr. **Weinberger**. I don't think Mr. Fulton is asking for any comment from me.

Mr. **Fulton**. Really I am. We are looking for methods. I would do it. Would you?

Dr. **Weinberger**. I would say that the question of incentives, both positive and negative, for providing the financial resources for accomplishing pollution control, this is certainly one of them that has to be explored with all the policy and public ramifications.

Mr. **Fulton**. My approach is not give them two carrots, by tax reductions, but add the tax on if they pollute. Do just the opposite. Don't try to ingratiate them. What do you think of that?

Mr. **Daddario**. I would think that that is a question Dr. Weinberger is not here to answer, Mr. Fulton. He could not say yes or no.

Mr. **Fulton**. This is your third rescue, Dr. Weinberger.

Dr. **Weinberger**. I appreciate the help from all of the members.

Mr. **Daddario**. Dr. Weinberger, taking your charts 2 and 3, however, recognizing what you are trying to accomplish, the fact is, as I understand it, 15 out of 50 States have submitted criteria for standards which you would approve. Do we really know what all of these graphs mean? Are these lines going to go really in this direction?

Considering the fact that the entire process of standard setting is occurring with very little knowledge of either the benefits or costs from controlling pollution; are we right or wrong? Are we doing too much or too little?

Mr. Brown raised a very good point. The economics of this could very well be a controlling factor. Do we know enough to point these criteria in the right direction?

I will quote from a statement by Jack W. Carlson, who is the senior staff economist with the President's Council of Economic Advisers.

He talks about the process of standard setting and goes on to say:

> Although the situation is lamentable, measurements take time and if some damage is obvious, though unmeasurable, some abatement is acceptable pending better determination of an appropriate level.

The whole thing gets kind of mixed up and because it is such a problem, we are thinking of spending some $26 billion in the next few years. Are we operating on such a shaky base. I would like your observation as to how do we handle this as we go along. Is our capability improving? Are we going to be stuck with this criteria only because we have come to some kind of estimated estimates to make these?

Are we going to remain flexible and change things around and be willing to admit mistakes if we need to?

Dr. **Weinberger.** Certainly, we have to be willing to modify some of these numbers when additional information is developed.

Let me comment on the validity or the amount of information that we have regarding the scientific base for setting these standards.

I think that we have a pretty good idea as to the maximum amount of these impurities that we can have in our environment. In other words, it is not that we have just an unrestricted range of values which we can tolerate. This is not really the issue. If one looks at some of the debates it may very well be as to whether the temperature should be 90° or 95°. It is not the question of whether it should be 90 or 110. So that I think that the information that we have begins showing that at certain concentrations we will have deleterious effects.

I think the problem in setting standards relates to making sure that we don't set the value too high because we don't fully understand all of the long-range effects and interrelationships among impurities.

I don't think there is anything inconsistent in establishing, if you will, a factor of safety which would say that we know that an organism will be destroyed at a certain concentration so let us apply a factor of two, three, four, or five since we don't fully understand what some of the more subtile effects will be.

Mr. **Daddario.** That is very fine, except there comes a great question of our ability to monitor so we know enough ahead of time. The problem is knowing enough ahead of time to be able to take the steps necessary to meet an emergency. Admitting that all of what you say is so, we still have to get the information to the people at the right time, and in sufficient time to enable them to do what is necessary to handle the emergency.

The ability to get an injunction to prevent automobiles from entering New York City, for example. It gets tremendously mixed up even though we have some idea about this criteria. Therefore, as we accept certain standards, are we also forcing the communities to develop the necessary steps? Are we developing the proper laws within which the courts can take action if the local officials refuse to?

Dr. **Weinberger.** I can respond very specifically to that.

The standards which are being set by the States and currently being reviewed and acted upon by the Secretary actually consist of two parts.

The standards consist of one part where the various criteria, the analyses, what measures we should take to determine the quality, are set forth. That is one part of the standards. The second part of the standards being submitted, or that have been submitted, involves an implementation program. Every State as part of its standards must come forward with an effective implementation program. The implementation program includes monitoring programs, insuring that they have proper legislation, insuring that they have the proper means for seeing that pollution control is carried out.

This is part of the standards setting.

Mr. **Daddario.** When you talk about safety factors, there is a safety factor upon which we can develop our existing knowledge. Do you put a cost-effectiveness price on that safety factor? Do you reach a point where not knowing what might happen we ought to be willing to pay something in order to prevent this from coming about?

Dr. **Weinberger.** The economics certainly come into play. There is no question but that when one develops control procedures that are inexpensive to carry out we do that even if we cannot demonstrate conclusively that this really results in improved water based on any physiological response. We have done that in the case of our present treatment technology for ordinary water.

So that let me try to give again an example of this, if I may.

Some of our earlier work indicated that a material killed fish. If at that time our techniques only really involved being able to determine the concentration which kills or does not kill a fish, that is pretty crude as a measure.

More recent work indicated that that same metal at one-tenth of a concentration made the fish sterile. This is the same, if you will, as killing the species outright.

If you will, if we had taken the initial value, we should have had at least a factor of 10, based on a lethal rate. Having reached now the figure of a tenth, the question is, with our limited knowledge how much lower than that should we go in the absence of scientific knowledge. We proceed very cautiously in requiring any lower value as a standard.

Mr. Chairman, I don't have the answers. There is obviously constant battle not only in water pollution but in any other field affecting health and well-being, welfare, constant battle as to how safe you must be, how safe can you afford to be.

Mr. **Daddario.** Dr. Weinberger, we don't ask you these questions because we believe you can give us a precise answer. There is much more that needs to be understood about it. We have to have more and better definitions from you people who are in fact going to handle all of this. This is why we ask these questions.

I would like to just go into this business——

Mr. **Ryan.** Could I ask a question?

Mr. **Daddario.** I have just one more question following this same line, and then I will recognize you.

As you apply your criteria, have you run into this situation? Or if you have not, what would you do if you do run into it. What would you do if you find a community or a State in a position where they do not have financial ability to handle this kind of activity? What do you do then to give them the hand necessary to develop their capital capability to handle these problems?

Take New York City, for example. If New York City were to say to you, "We would like to improve the percentage of removal that Mr. Ryan was talking about, but we just can't afford it. We can afford to get up to 70 percent, but not 85 or 90 percent." How do you give them a helping hand, or can't you?

Dr. **Weinberger.** The amount of help that we can provide is quite limited. We do have a construction grant program which is made available to the States. There is a very limited amount of funds that can be moved from one area to another.

Mr. Chairman, we come back to the question that I mentioned when I started; that is, what is it that we can afford to pay? There was one enforcement action that we held where a city was required to put in waste treatment facilities. The city did not pass the bond issue. Steps were taken to bring the parties into court. Under those circumstances a bond issue was passed and the plant was built.

Again we get down to the point of what is it that the people will pay for these facilities?

A specific answer to your question is the amount of help that we can provide from a financial point of view which would be pretty much through our existing construction grant program.

Mr. DADDARIO. The possibility does exist that there will come a time, or could come a time, when the locality involved is not willing to meet these requirements and would develop a pollution problem which might in fact affect the entire area, or other States as well? The laws prevent you from doing one thing and you know the danger still exists.

Are we moving to the time when as these things develop, we will most likely have some national funds to meet those emergencies?

That gets us back to Mr. Fulton's question.

Dr. WEINBERGER. Yes, I think it goes back to our existing legislation. I think you gentlemen are all familiar with the appropriations in terms of providing additional funds for construction grants.

Mr. DADDARIO. These are things we certainly should keep in mind. Mr. Ryan.

Mr. RYAN. Is it the intent of the Federal Government to enforce standards once they have been submitted and approved?

Dr. WEINBERGER. Yes, sir.

Mr. RYAN. That being the case, then I do not understand how the Federal Government could fund the construction of a plant which on the face of it will not meet those standards. In other words, if an exception is made in New York and you permit New York City to build a plant which on the face of it does not meet the standards approved for the Hudson River, through a conference and also through approval of the Secretary on standards, then you are openly encouraging defiance of your own regulations and standards approved by the Secretary.

How could the Department be in that untenable position: On the one hand saying we are going to enforce Federal standards which are 80 percent removal of BOD, and, on the other hand, approve 55-percent construction grant for a project which violates 80-percent removal of BOD standards?

There has to be some coordination within the Department so that you resolve this question. If you make an exception in New York, why not an exception in every one of the other 49 States?

Dr. WEINBERGER. Mr. Ryan, again as I indicated, I will try to elaborate on this. Unfortunately, I don't have the information on New York standards nor the particular Hudson conference, but I will be pleased to get it and present it in detail to you.

Mr. **Ryan**. Would you agree the Department would be in a very untenable position if it said it was going to enforce Federal standards and at the same time on the other hand approve and pay out Federal moneys for something that did not meet those standards?

Dr. **Weinberger**. I would——

Mr. **Ryan**. That is susceptible of a "Yes" or "No" answer.

Dr. **Weinberger**. I would suggest that if, indeed, we carried out a program which resulted in our encouraging violations of our own standards, this would not be a very good situation to be in.

Mr. **Ryan**. That is where the Department is today.

Dr. **Weinberger**. I will look——

Mr. **Ryan**. That is my statement.

Dr. **Weinberger**. All right, sir.

The information requested is as follows:

WASTE TREATMENT WORKS CONSTRUCTION GRANTS REQUIREMENT

When an application for a construction grant is received, it is reviewed to assure that the proposed project will meet all Federal requirements, including conformance with approved water quality standards. If a proposed project of itself does not provide the degree of treatment required by the standards, it will not be approved for a grant unless the applicant shows a firm intent to provide the required degree of treatment within a specified length of time.

Mr. **Daddario**. Mr. Fulton. One more question and then we will allow Dr. Weinberger to finish. I would like then, if possible, to have Dr. Pecora make his statement, which is relatively short, and Mr. Everts.

Mr. **Fulton**. My point is along the lines of the first comment.

Ten-percent pollution made the fish sterile, you said. What happened to the people in that locality? Was there any effect on the people if that occurred to the fish and was provable?

What is the effect on people of the varieties of pollution, both air and water, because we can show generally that there is a marked distribution pattern on the types of cancer, for example, lung, throat, kidney, liver, even on the breast cancer.

There is a remarkable correlation with the water systems and air pollution systems on types of cancer.

For example, sinus trouble or multiple sclerosis occurred amazingly along our river system and not in our mountain areas.

I would like a statement of what correlation we are trying to get among those particular factors for the record.

(Information requested is as follows:)

DEPARTMENT OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

CORRELATION BETWEEN WATER POLLUTION AND HUMAN DISEASE

Reorganization Plan No. 2 of 1966, which transferred from the Secretary of Health, Education, and Welfare to the Secretary of the Interior responsibility for the administration of the Federal Water Pollution Control Act, excepted from the transfer certain functions related to the public health aspects of water pollution. The plan directed that the two Secretaries present to the President an interdepartmental agreement for the implementation of the requirement that the Secretary of the Interior consult the Secretary of Health, Education, and Welfare on public health aspects of water pollution.

This "Interdepartmental Agreement Concerning Health Aspects of Water Pollution Control" directs that the Secretary of Health, Education, and Welfare be consulted on the following health-related matters: criteria for water quality standards setting based on health aspects of intended use for drinking water supplies, shellfish and other marine food production, bathing and other water contact activities; specific water related health problems, such as comprehensive water pollution control programs and water pollution research projects; and construction grant applications and requirements for the control of pollution from Federal installations where projects may adversely affect shellfish-growing areas.

In conformance with the Agreement, the Federal Water Pollution Control Administration is using Public Health Service Drinking Water Standards as the general basic requirements for protecting public water supply use of interstate waters, and is using Public Health Service Shellfish Sanitation Standards as the basic bacteriological requirements for protecting shellfish waters. The Federal Water Pollution Control Administration solicited the participation in the water quality standards-setting process of Public Health Service officials, who have served as representatives to the National Technical Advisory Committee on Water Quality Criteria. In addition, at the regional level Federal Water Pollution Control Administration Regional Directors have worked with the staff of the Public Health Service in the review of individual State water quality standards.

In carrying on a national program for the prevention, control, and abatement of water pollution, the Federal Water Pollution Control Administration gives major attention to the protection of human health. Our objective is the preservation and restoration of water quality for every legitimate use, including public water supply, recreation, and other uses which affect the health of man. The establishment of water quality standards, the enforcement function, and other major program activity is directed in large part to the protection of public health and welfare.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
March 14, 1968.

Memorandum to: Dr. Leon Weinberger, Assistant Commissioner for Research and Development, FWPCA. Attention: Mrs. Seligson.

From: Deputy Director, Bureau of Disease Prevention and Environmental Control, PHS.

Subject: Material for Daddario Committee on "Effects of Water Pollution on Human Health."

In accordance with your request, there is forwarded herewith a draft of material for insertion in the recent Daddario Committee hearings on the above subject. Please excuse the delay in getting this material to you.

V. G. MACKENZIE,
Assistant Surgeon General.

EFFECTS OF WATER POLLUTION ON HUMAN HEALTH

Water pollution directly relates to man's health through:

1. Contamination of his drinking water,
2. Destruction of water contact recreational and work areas,
3. Contamination of his food sources, particularly marine food, and
4. By creating environmental areas which produce disease carrying insect vectors.

While the broad parameters of these effects are generally recognized, the increasing discharge of wastes to water resources is exposing man to an increasing degree to low levels of potential hazardous chemical intoxicants which may have a direct effect on his health. This problem is well illustrated by a review of the Public Health Service Drinking Water Standards which contain limits for microbiological, chemical, and radioactive contaminants. While efforts have been made to develop these standards in the light of man's total exposure through the mediums of air, water, and food to particular chemicals, lack of knowledge as to the long term chronic effects of these substances is notable by its absence. Without such information, it is difficult, if not impossible, to establish minimum tolerance levels for inclusion in standards on potable water quality. Furthermore, the increasing contribution of industrial waste containing both inorganic and organic chemicals or unknown or undetermined composition also complicates the problem. Many of the chemical limits contained in the Drinking Water Standards relate to time-honored materials without appropriate recognition of new and exotic forms of chemicals which pass through both sewage and waste treatment plants and water supply treatment plants with little or no reduction.

The total body burden exposure is becoming increasingly important. It is essential that total intake of a given chemical by man be considered in establishing the respective limit for its presence in air, water, and food. An excellent example in this regard relates to lead in the environment which is present in water, air, food, and cigarette smoke. Relative judgments have to be made as to the appropriate levels in each of these categories in order to establish meaningful standards.

The lack of specific guidelines is well exemplified by the establishment of a limit for carbon chloroform extractables in the Drinking Water Standards. These are organic materials which can be removed by the use of activated carbon and the standard provides a gross measure of organic materials which may be present in the water supply. Laboratory studies have indicated that these materials are carcinogenic in nature. While still at an extremely low level of concentration in many of our municipal water supplies, studies are needed in order to identify the particular chemicals to permit the establishment of limits for various organic chemicals hazardous to health. The difficulties in trying to establish absolute limits for all chemicals which may be found in drinking water supplies are obvious. Nevertheless, a surveillance program is needed in order to provide better information on the types of chemicals which are increasingly finding their way into water supplies, both ground and surface. It is essential that a continuing review and appraisal of the Drinking Water Standards be maintained in order to keep abreast of the problem.

CHEMICAL EXPOSURES

The following specific examples highlight the importance of chemicals in our domestic water supply. Marked geographical differences have been noted in mans' morbidity and mortality rates. It is reasonable to assume that some of these rates might be related to the varying chemical composition of drinking water supplies. As noted above, potential carcinogenic and toxic substances are being found in water sources although currently at levels which are not believed to be hazardous. Some of these substances are incompletely removed by conventional water treatment methods. Distribution of death rates for malignant neoplasms of digestive organs, cirrhosis of the liver, and chronic and unspecified nephritis in certain metropolitan areas suggests that there could be an association with drinking water quality.

Specific examples of health problems to which answers are needed on the subject of contaminants in drinking water supplies may be listed as follows:

1. The increased incidence of cancer of the bladder in certain geographical areas of the country where the raw water supplies have received the municipal, industrial, and agricultural wastes of up-stream cities on the Mississippi-Missouri-Ohio river chain.
2. The potental toxicity of high nitrate concentration currently known to cause methemoglobinemia in infants.
3. The limits for lead in water supply in terms of whole body exposure and its potential as a cumulative poison in humans.
4. The fate of antibiotics, hormones, and similar materials in waste waters discharging to sources of water supply must be established.
5. Further exploration of the relationship of copper to arthritis.

The above are only a partial listing of the health-related problems of chemicals in drinking water supplies. While progress is being gained in securing municipal and industrial waste treatment facilites throughout the nation, these plants are not always effective in the removal of the dissolved inorganic and organic chemicals which are believed to have toxic potential to the human organism. Basic to all studies of the effects of chemical contaminants in water supplies is the need for more precise and sensitive methods for the identification and measurement of both known and unkown contaminants. The increasing occurrence of pesticides in water supplies and their potential toxicity to man may require changes in water treatment practices.

BIOLOGICAL EFFECTS

While many of the classical communicable diseases such as typhoid fever, amoebic dysentery, bacillary dysentery, and gastroenteritis transmitted by water have been brought under control, waterborne epidemics are still occurring in this country. During the period 1946–1960, there were 228 waterborne disease outbreaks which resulted in 25,984 cases of illness. For example, a waterborne outbreak of salmanellosis in Riverside, California in 1965 resulted in some 18,000 cases of the disease.

In view of these continuing outbreaks, the question can logically be raised as to the reliability of time-tested safeguards and safety factors applicable to the production of potable drinking water. Substantive questions have been raised as to the adequacy of coliform organisms as a measure of safe water quality. It is known that viruses in water supplies react differently than bacteria. Until studies can be made to demonstrate the efficacy of the current water treatment practices, this question will remain. In light of the proposals to permit the reuse of treated sewage effluent, the adequacy of the coliform organism as the indicator of pollution must be critically examined. The standard bacteriological method requires approximately 18–24 hours for preliminary results which does not permit the degree of close control and surveillance required when sewage reuse is being proposed.

FOOD SOURCES

Another area in which water pollution has a health impact is in the food production and processing industry. This is best illustrated in the case of shellfish which are filter-feeders with almost unparalleled ability to extract and consume biological and chemical contaminants from polluted water. Since many shellfish are consumed raw, the ultimate effects of contaminated shellfish are self-evident. Considerable effort is required in order to preserve the quality of shellfish-producing waters. The relationship of water supply to the growing and processing of food is also well recognized. Fortunately, most of the processing does result in the production of a food that is safe. With the increasing use of land surface for the disposal of wastes, however, the situation may change. The use of water in food processing operation may result in concentration of the chemicals present and their retention in the food.

RECREATIONAL USE OF WATER

The pollution of water resources creates a hazard to individuals using such waters for body contact sports. Typhoid fever outbreaks have resulted from swimming in areas polluted by human sewage. Contamination of water by domestic or wild animals has resulted in outbreaks of leptospirosis in humans. It is essential that we develop new and improved indices of bacteriological quality for recreational waters. As a health related problem the destruction of the aesthetic qualities of water have a detrimental effect on the use of these waters for recreational and scenic purposes and population groups are denied the health related benefits therefrom. Fish taken from such waters may contain toxic levels of certain chemicals which have been concentrated in the flesh of the fish.

BREEDING OF DISEASE VECTORS

The improper management of water resources may provide areas for the breeding of insect vectors capable of transmitting human disease. Mosquito vectors of encephalitis appear to reproduce more prolifically in polluted water. The normal problem of insect vector control measures at water impoundments take on a more significant aspect in relation to this phenomenon.

Individuals involved in water contact occupations such as fish and boat washing operations are potential victims of schistosomiasis from pollution of their water environment with wastes from humans infected with the disease. More adequate measures must be developed for the treatment of these wastes as well as for control of the snail which acts as an intermediate host in the life cycle of the parasite.

Proper control measures can be applied to prevent the gross production of such vectors of disease.

RADIOLOGICAL EFFECTS

The effects of radiation on human beings are viewed as harmful and any unnecessary exposure to radiation in the environment should be avoided.

The development of the nuclear industry has been attended by a small unavoidable increase of radioactivity in the environment. Above average levels of intake occur only in unusual situations where drinking water may contain naturally occurring Radium 226 in greater than average amounts, or from pollution of a water supply by industrial discharges of wastes containing radioactive materials.

CONCLUSIONS

In a recent report to the Secretary, Health, Education, and Welfare, "Strategy for a Livable Environment", June 1967, the statement was made that "50 million Americans drink water that does not meet Public Health Service Drinking Water Standards. Another 45 million Americans drink water that has not been tested by the Public Health Service." This represents a rather sad commentary on the state of surveillance of domestic water supplies in this country. The Task Force which prepared the report recognized the need for a new and larger approach to protect the public from environmental health hazards incident to water pollution and as it relates to drinking water supplies. A substantive question can be raised as to whether our present protective barriers are being strained to their ultimate limit without due regard for an examination of the future potential of the numeous problems in the water supply field as outlined above.

One other point. When you speak of the grants to the States for construction of facilities to prevent pollution or clean it up, it is really the understatement of the year when you say that funds are limited. The answer is that there are not any. There are too many applications to take care of even in part the proposals that have been made, or that Mr. Ryan is speaking about. You are so far down the list of applications that you just might as well give up to the Federal Government.

For example, in Pennsylvania we have figured that in a period of 5 years if we went after pollution of mine drainage alone, or surface mining, it would take $3 to $5 billion.

You just cannot do it. There are not funds; are there? You do not have funds; do you?

Dr. **Weinberger.** We do not.

Mr. **Fulton.** There are no funds in the Federal Government for this construction at the present time because the applications are tremendous and the funds are miniscule; is that correct?

Dr. **Weinberger.** Yes, sir.

Mr. **Fulton.** That is all.

Mr. **Daddario.** You would not agree it is a hopeless situation?

Dr. **Weinberger.** Absolutely not.

Mr. **Daddario.** Finish your statement.

Dr. **Weinberger.** Thank you, sir.

Mr. **Fulton.** The chairman had commented on your charts with the inference they either were completely no good, partially no good, or slightly no good.

Mr. **Daddario.** Those are your own conclusions, not mine.

Mr. **Fulton.** I think if you will read the record, the question then is: How did you make up your charts? What sources? How did you make these figures that are now questioned, whether they are good enough even to rely on? Who made the charts and how were they collected?

Dr. **Weinberger.** I would want to comment on that.

Mr. **Daddario.** I think you should.

Dr. **Weinberger.** It is one point that I think is quite important that again we indicate.

The work in developing the cause-effect relationship has been pursued for many years. There are two Federal laboratories that were authorized by the Congress in 1962 specifically for the purpose of carrying out the necessary research to determine water-quality requirements.

One of these laboratories is at Duluth and the other is at Narragansett in Rhode Island. Both of these laboratories will be developing increased information on these cause-and-effect relationships. The information that is available, Mr. Fulton, is information which has been carried out in our laboratories, laboratories of other Federal agencies, State agencies, universities, by competent scientists all over the country and, indeed, all over the world.

This information is, if you will, summarized in the report of this national advisory committee. The technical information has been accumulated in laboratories all over this country, in Federal laboratories, university laboratories, industrial laboratories, on the basis of field and laboratory studies.

Mr. **Fulton.** Are they narrow or broad figures? Are they figures with a history or are they just current figures?

Dr. **Weinberger.** Some of them are figures with a history.

Mr. **Fulton.** I wish you would put a statement in the record on that.

Dr. **Weinberger.** I would be happy to do that.

(The information requested is as follows:)

The use of charts 2 and 3 was meant to serve the purpose of illustrating concepts rather than to convey any types of precise quantitative relationships.

Figure 2 refers to a relationship between the concentration of a pollutant and the time of exposure of that pollutant to the water use. Degrees of damage or effect upon the water use produce a family of curves. For certain pollutants these effects are fairly well known and such a curve could be delineated with accuracy. Figures 2A and 2B are examples of the bases for these curves. For most pollutants, however, these cause and effect relationships are not well understood and a great deal of the further work must be done. This is true especially when two or more pollutants act together and the result produces a synergistic or antagonistic effect. Also, a pollutant exhibits varying effects in water of different physical and chemical characteristics. The relationship shown in Figure 2 could be more accurately presented as bands rather than as distinct lines. Here again, the qualitative concept and not a quantitative relationship is implied.

Shown in Figure 3 is an attempt to demonstrate the conceptual relationship between cost and removal effectiveness. The intent of the chart is to convey qualitative and not quantitative information although quantitative information is certainly readily available for certain pollutants, e.g. organic matter, phosphates, inorganic matter, color, etc. Examples of these BOD and COD removal are illustrated in Figures 3A and 3B. The concept is that in order to achieve lower and lower final concentrations, greater and greater costs are required for each unit of concentration removed. Treatment costs are also dependent upon the initial pollutant concentration in the untreated water, thereby producing a family of curves as shown.

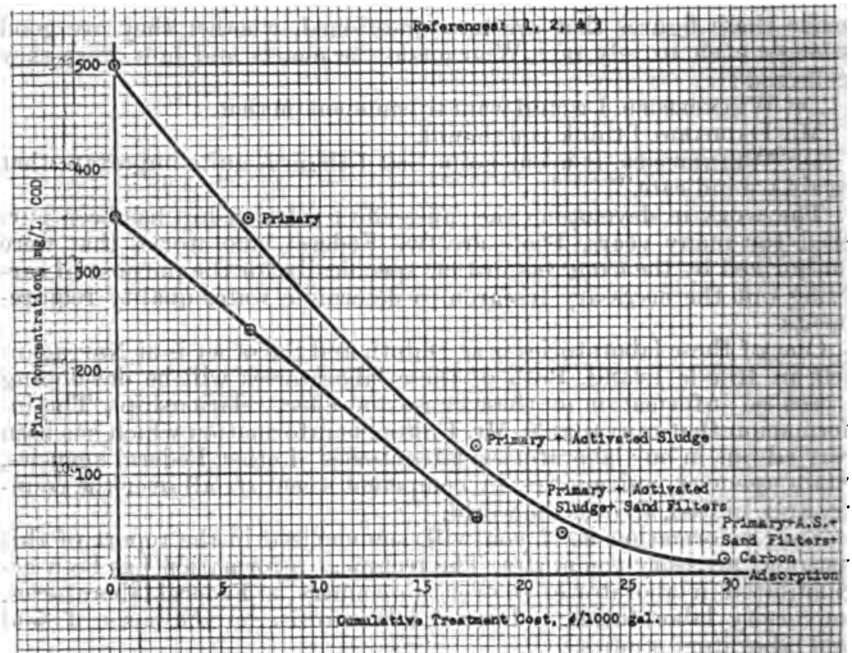


Figure 3B. COST TO ACHIEVE FINAL COD CONCENTRATION

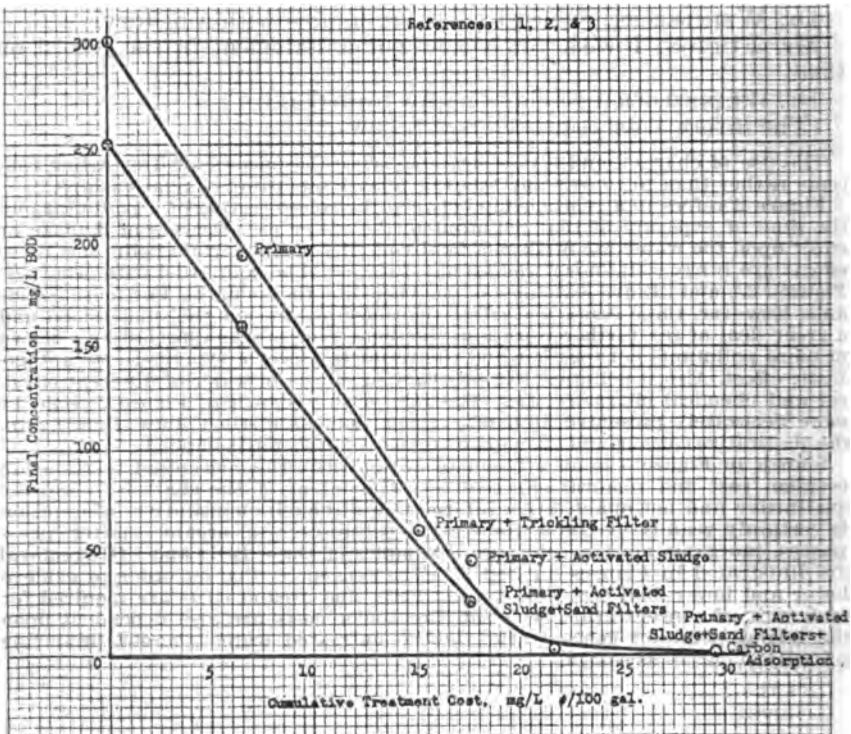


Figure 3A. COST TO ACHIEVE FINAL BOD CONCENTRATION

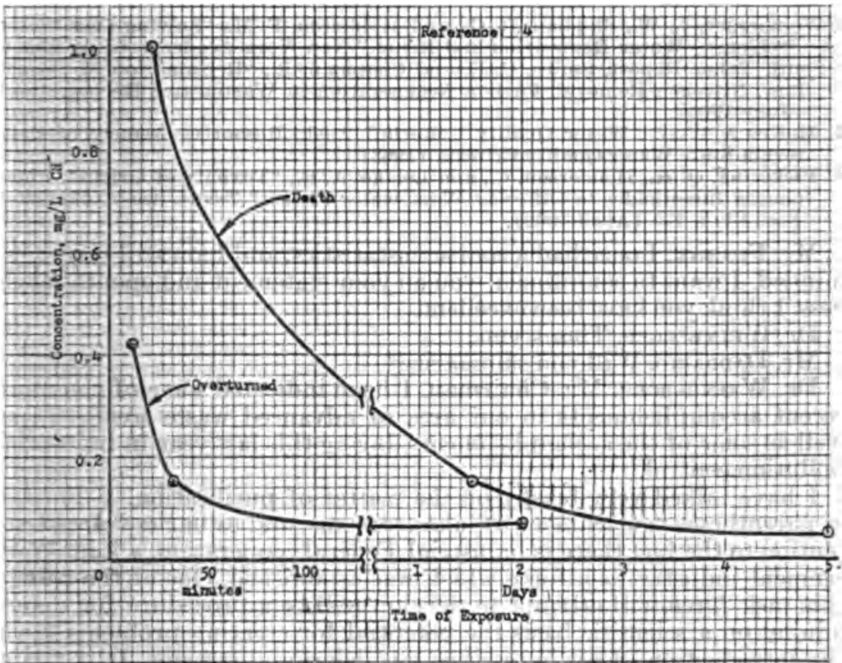


Figure 2A. EFFECTS OF CYANIDE ON TROUT

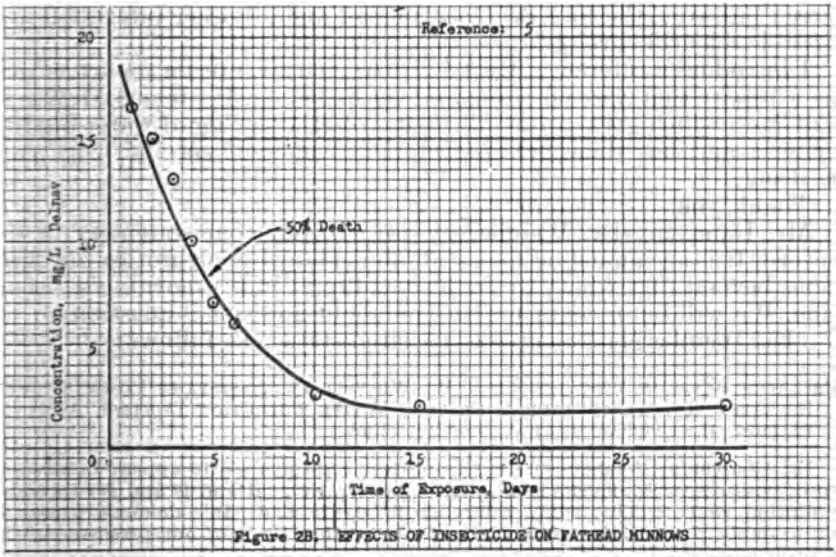


Figure 2B. EFFECTS OF INSECTICIDE ON FATHEAD MINNOWS

REFERENCES

1. Smith, R., "A Compilation of Cost Information for Conventional and Advances Wastewater Treatment Plants and Processes," FWPCA, U.S. Department of the Interior Advanced Waste Treatment Branch, Div. of Research, Cincinnati, Ohio (Dec. 1967).

2. Weinberger, L. W., Stephan, D. G., and Middleton, F. M., "Solving Our Water Problems—Water Renovation and Reuse," New York Academy (July 1966).
3. South Tahoe Report, Smith, C. E. and Chapman, R., "Reclamation of Coagulant, Nitrogen Removal, Carbon Regeneration in Wastewater Reclamation" (June 1966).
4. McKee & Wolf, "Water Quality Criteria," 2 ed., Resources Agency of California State Water Quality Criteria (1963).
5. Pickering, Q. H., Henderson, C., and Lemke, A. E., "Toxicity of Organic Phosphorus Insecticides to Different Warmwater Fishes," *Trans. Amer. Fisheries Soc.*, 91, 2, 175 (April 1962).

Mr. **FULTON**. I once had a course in statistics, and I am still statistics-minded. I want to compliment you on your statement and openmindedness. I think you have been excellent.

Dr. **WEINBERGER**. Thank you.

Mr. **DADDARIO**. Will you summarize?

Dr. **WEINBERGER**. Mr. Chairman, I have indicated some of the more recent accomplishments in our area of advanced waste treatment as well as some of the accomplishments during this last year in industrial pollution control.

I have talked very briefly on the matter of purification. I do have in parentheses "enrichment of lakes, streams, and estuaries." I call attention to the fact there is industrial-Federal cooperation, a joint Government-industry task force which was established. One of the things this task force will attempt to develop will be a procedure for determining on a scientific basis the potential for creating problems from the introduction of all impurities into lakes and streams. It is again recognized that our information is limited in this field and that we need some more scientific information if there is to be cooperation between industry, the Federal Government, and all other interested and capable scientific groups.

I introduce a reference, Mr. Chairman, to this interim report as well as a report that was not prepared by us but by Professor McKie at Cal Tech which goes into a full treatise on the setting of water quality criteria and has thousands of references in it of specific work carried out.

Thank you.

Mr. **DADDARIO**. Dr. Weinberger, we will put your statement in the record. It is an important one, and offers many opportunities for questions beyond that which we could possibly fit into a morning's discussion. We will be in contact with you about additional questions.

(Dr. Weinberger's complete prepared statement follows:)

PREPARED STATEMENT OF DR. LEON W. WEINBERGER, ASSISTANT COMMISSIONER, RESEARCH AND DEVELOPMENT, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, U.S. DEPARTMENT OF THE INTERIOR

Mr. Chairman, Members of the Committee, I am pleased to appear before you to discuss research, development, and demonstration (R and D and D) in water pollution control. This early reference to the second "D"—demonstration—is quite deliberate because of the importance of that facet of our program in the prevention and control of water pollution.

ROLE OF R AND D AND D IN POLLUTION CONTROL

An effective water pollution control program consists of a number of elements, namely: scientific and technical answers and solutions, economic resources to construct and operate pollution control facilities, a strong enforcement and program implementation effort, adequate planning and administration, and competent manpower. Research and development is needed to provide new and improved analytical tools, scientific knowledge, and engineering controls. I, of course. do not intend to minimize the importance of role of research and development; however, we should recognize that many of the water pollution problems facing our nation today can be alleviated by the application of existing technology. In fact, in the immediate future, the most significant progress will be made in this way. Through research and development, we will find solutions where none now exist, we will better define the effects of impurities on water uses, we will improve the effectiveness of available solutions, and we will reduce the costs of waste treatment systems. Gentlemen, I have complete confidence that we will find solutions—acceptable solutions, in my opinion—to all our pollution problems.

The solutions will be satisfactory from a scientific and technical point of view, but *they will cost money.* Although you may believe that it is obvious that pollution control will cost money, there are many polluters who are apparently unwilling to recognize any solution as acceptable unless it is a zero cost solution. We shall seek these zero cost solutions—indeed, in some instances, through wastes recovery or by-product development, a profit may be realized—but we must be willing to pay for pollution control. What is meant by an economically acceptable solution is certainly to be the subject of considerable debate. Conventional cost-benefit analyses are not totally applicable because we are not able to define in a quantitative manner all the benefits of water pollution control nor assess the total damages resulting from water pollution. Research into the socio-economic aspects of water pollution control may provide us with some of these analytical tools—tools which will enable us to evaluate the "intangible" benefits.

COSTS AND BENEFITS OF WATER POLLUTION CONTROL

Our knowledge of the costs and benefits associated with water pollution control is rapidly improving.

The Federal Water Pollution Control Administration has just completed a study entitled "The Cost of Clean Water." This is in response to Section 16(a) of the Federal Water Pollution Control Act, as amended, which directs the Secretary of the Interior to conduct a comprehensive analysis of the national requirements for and the cost of treating municipal, industrial, and other effluent to attain water quality standards established under the Act. These first analyses are required to be submitted to the Congress in January 1968 to cover Fiscal Years 1969–73, inclusive, and to be updated each year thereafter.

These studies are extremely important because, although there is widespread agreement that water pollution is a significant, growing problem which must be dealt with, there are no firm estimates as to what the national requirements are, or what it will cost the Federal Government and other affected units of government to achieve a satisfactory abatement level. Various cost estimate studies of municipal and industrial needs have been conducted in the past but they have not been sufficiently comparable in geographical coverage, time phases covered, cost criteria, types of facilities included, or in cost estimate technique to provide a fully meaningful guide to the national requirements and costs involved.

The "Cost of Clean Water" study represents the initiation of what will be a continuing evaluation, aimed at developing more accurately the national costs of pollution control. Although it has not been possible to arrive at a completely definitive estimate of required costs, it is believed that the present study provides a more comprehensive cost estimate than has previously been developed and a sound base of information upon which to build future analyses. This estimate is expected to improve in accuracy with each yearly updating.

Other studies being completed under the requirements of the Federal Water Pollution Control Act include a study of the economic impact on affected units of government of the cost of installing waste treatment facilities, and a study of possible economic incentives to industry for pollution control. Both these studies will add substantially to our knowledge of the economics of the problem.

Determination of benefits is far more difficult, since many of the benefits of pollution control are non-monetary in nature. However, some progress in quantifying pollution control benefits is being made. A specific example is in the comprehensive water quality control study conducted by the Federal Water Pollution Control Administration in the Delaware River Estuary. In that study five water quality objectives were analyzed to determine the costs of their achievement by various means and the financial and economic benefits expected to accrue from their fulfillment. The study was conducted over several years with the cooperation of State and local governments and industry. Therefore, considerable detailed data not usually available were analyzed in developing the proposals. The study has become a model for this kind of exercise and is being adapted in other regions in those cases where this type of analysis is needed to guide pollution control decisions.

RESEARCH AND DEVELOPMENT PROGRAM AND PLANNING

Figure 1 illustrates the program structure and elements of the research and development program of the Federal Water Pollution Control Administration. It represents the framework within which we can plan our program, establish goals and determine needed resources to achieve goals, allocate available resources, and evaluate the effectiveness of ongoing research. Subprograms 11, 12, 13, 14, and 15 contain the elements dealing with specific sources of wastes; subprogram 16 is a general category containing the elements of pollution identification, fate and persistence of pollutants in the invironment, water quality control, eutrophication, water resources planning and resource data, cold climate research, and basic research; subprogram 17 contains the elements dealing with waste treatment; and subprogram 18 is the research on water quality requirements or effects of water pollutants on all water uses. The element 1608—Water Quality Control encompasses pollution control techniques such as recovery and reuse, product modification, process change, elimination, dispersion, dilution, detention, diversion and environmental treatment. This structure for categorizing our research and development was established last year and we believe will facilitate interagency coordination and cooperation. The categories are compatible with those established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

RESEARCH PRIORITIES

The research program of the Federal Water Pollution Control Administration is directed primarily to the *solution* of water pollution problems.

In planning research, a major task is to establish priorities of research within available resources and the directives provided by legislation. In our program priorities are based on the needs, recommendations, and ongoing research of the following:

1. FWPCA Regional Directors and their staffs. They are knowledgeable of the problems as they exist or may develop in their respective regions (river basin),
2. FWPCA program directors at headquarters,
3. Other Federal agencies,
4. State and local agencies,
5. University professors and researchers,
6. Consultants and advisory groups,
7. Committee on Water Resources Research, and
8. Industrial groups.

The setting of research priorities and the allocation of research resources is still, to a considerable extent, based on a subjective analysis. The analysis, however, has considerable merit when carried out by competent knowledgeable people who have available to them the information obtained from answers to the following series of questions:

1. What is the problem?
2. What is the magnitude of the problem?
3. What answers or solutions do we need?
4. What answers or solutions are available? (The statement of problem should not be considered equivalent to needed research.)
5. When do we need the solutions?
6. What are the specific objectives being sought? What answers are being sought? How will you know when these objectives have been achieved or answers found?

7. How much work has been done on this problem to date, by whom, and when was it started? Has an adequate literature review been made? What is the magnitude of the ongoing research effort and who is doing it? What cooperative work is being undertaken and by whom?
8. What work is being planned by others? (NOTE: This is probably the most difficult information to obtain.)
9. Can the answers be obtained from proposed research?
10. What will be the total cost of research and development and demonstration effort to obtain answers?
11. How long will it take to obtain answers? When will project be terminated?
12. What effort or information must be provided by others in order to complete research?
13. If new answers are found, will they have any significance?
14. How are the results to be disseminated? How will effort be coordinated with other related programs?
15. Should research be carried out at laboratory, pilot plant, or at field evaluation scale?
16. How much replication of effort should be carried out?
17. What types and levels of competence of personnel are required? Do we have these people?
18. What facilities, equipment, and instrumentation are required? Are these available?
19. Should the work be performed in-house, by grants, or by contracts? Where can the work best be done? If in-house, which laboratory? If contract, are there contractors with special or unique competence?
20. Are there other approaches to solving the problem? What are they?
21. Does proposed approach and methodology differ substantially from those recognized in the field of study? Why?
22. Has the proposed program been subjected to technical review?
23. Are there predictable technological developments in this or related fields which could substantially affect your research effort?
24. If program or project is approved, when can the next decision be made as to termination or continuation of work?
25. What is probability of success?

The implementation of approved program plans consists of the following aspects:

1. Development of detailed operational plans and resource requirements.
2. Review and approval of detailed plans.
3. Allocation of resources.
4. Reports and review of progress and resources utilization.
5. Evaluation of progress.
6. Redirect efforts as necessary to incorporate new decisions, results, and actions affecting program.
7. Publication and disemination of results.
8. Integration of research efforts into total solution of problem.

ALLOCATION OF RESOURCES

The research and development program of the FWPCA is conducted through both in-house and extramural support. The in-house effort is conducted at laboratories at Corvallis, Oregon; Ada, Oklahoma; Athens, Georgia; College, Alaska; Duluth, Minnesota; and Cincinnati, Ohio, and although the permanent building has not been constructed, at Narragansett, Rhode Island. Additional research and development is conducted at field sites across the nation.

It is obvious that to have a successful research and development program, in addition to the competence available in the Federal Government, the best scientific and engineering talent in the nation including that available in the university and private research institutions, industries, and in state and municipal organizations, must be incorporated in the national effort to control water pollution. This we are doing through our extramural grants and contracts. It is important to note that approximately 80% of our research and development funds is spent in our extramural program.

Our experience has demonstrated the great importance and efficiency in conducting simultaneous and complementary in-house and extramural research projects. It has also shown that the overall effectiveness of grant and contract research can be very greatly enhanced through the intensive application of technical direction, coordination, and monitoring. A grant and contract support staff of engineers, scientists, economists, and other professional personnel must provide continuing planning, data interpretation and analysis, and systems optimization services to the program by using the most up-to-date techniques and principles, such as operations research, critical path ananlysis, and cost engineering. This staff must develop the interest and obtain the ideas and suggestions of the most competent scientific and engineering minds in the Nation; encourage the submission of proposals in light of the overall broad attack on the problem; monitor, direct, and coordinate projects in progress; and interpret and evaluate results and recommend continuance, termination, or redirection of the work. The staff must also conduct adequate liaison with other agencies and organizations, both within and without the Federal government.

The assistance of industry, in the form of ideas, processes, products, or services, will undoubtedly hasten the solution to some of the Nation's industrial and nonindustrial pollution problems. Industries, for purposes of research and development, may be classified as follows:

1. Industries having a pollution problem.
2. Industries who have or expect to develop a commercial position in pollution control equipment, chemicals, instrumentation, processes, systems, or services.
3. Industries having a research and development capacity which has not been directed to pollution control.
4. Combinations of the above.

I would like to point out some of the factors which industry considers in participating in a federally supported research and demonstration effort.

POSITIVE FACTORS

1. Fees associated with contract.
2. Experience gained by personnel.
3. Advance of technological position.
4. Publicity associated with contract award.
5. Financial risk minimized.
6. Earlier demonstration of efficacy of results thereby establishing market.

NEGATIVE FACTORS

1. Time and effort of proposal preparation.
2. Time and effort of proposal negotiation.
3. Diversion of competent personnel from other research and development activities.
4. Personnel who have gained experience at company expense produce results available to competitors.
5. Contractor's art may be disclosed earlier than usual to competitors.
6. A non-contracting competitor can improve his competitive position with a minimum of contribution and a minimum of risk.
7. Unfavorable publicity resulting from negative results.

DEMONSTRATION AND FIELD EVALUATION

Earlier, I mentioned the importance of the demonstration aspects of our research and development and demonstration efforts. On May 11, 1966, before the Subcommittee on Air and Water Pollution, Committee on Public Works, United States Senate, we stated the following:

"The solution of water pollution problems will require the application of existing techniques plus additional research and development for new and improved techniques. Research and development generally goes through a series of steps ranging from exploratory studies through laboratory research, field evaluation, and demonstration. In the past, our efforts have been mainly in laboratory research and there has been a recognized deficiency in the application of research findings. The application of research findings requires that someone undertake the construction and operation of a new type facility which is often very expensive and which is associated with a greater risk of failure than with processes which are already proven in practice. The construction of remedial facilities in water pollution control is the responsibility, to a considerable extent, of local authorities who may have limited financial resources. Often these authorities feel that they cannot afford the risk associated with trying new methods. It may very well be in the best public interest for the Federal government to design, construct, and operate full-scale facilities to develop and demonstrate new ways of pollution control. Such facilities could be built in cooperation with existing or new municipal installations or at Federal installations."

The Clean Water Restoration Act of 1966, which amended the Federal Water Pollution Control Act, provides for grants for the purpose (1) of assisting in the development of any project which will demonstrate advanced waste treatment and water purification methods or new or improved methods of joint treatment systems for municipal and industrial wastes, and (2) for research and demonstration projects for prevention of pollution of waters by industry including, but not limited to, treatment of industrial waste. This program is approximately one year old and there is ample evidence to indicate that the most significant contribution to the solution of water pollution by the development and application of new and improved technology will result from this program.

The Pulp Manufacturers Research League, Inc., in their 1967 Annual Report, made the following reference to grant support which they received from the Federal Water Pollution Control Administration:

"A fair estimate is that this League—Federal project will move ahead by as much as five years the time when pulp and paper mills will have a solid dollars and cents foundation upon which to base a yes or no decision for reverse osmosis. If this in-plant process proves as sound financially as it is already proved technically, the industry will have an effective and economical method for treating dilute effluents to a previously unattainable level of purity."

A complete listing of our grant and contract awards for projects authorized under this new legislation is available. As of January 25, 1968, 84 grants and contracts totaling $33,257,950, including storm and combined sewer projects, have been awarded.

MAJOR WATER POLLUTION PROBLEMS

Figure 1 represents the total scope of the research and development efforts of FWPCA. Each of the elements is important in our drive toward total pollution control; however, some problems stand out because of their magnitude and the need for solutions in the near future:

1. Municipal waste treatment.
2. Industrial waste treatment and control.
3. Improved methods for measuring effects of pollutants (water quality requirements), including temperature effects.
4. Disposal of impurities (solids) removed from wastes.
5. Mine drainage.
6. Irrigation return flows.
7. Agricultural land runoff.
8. Storm and combined sewer discharges.
9. Lake, estuary, and ocean disposal of treated and untreated wastes.

We have discussed these problems before, but I would like to dwell on one of them to illustrate what can and should be done in solving the problem. Municipal waste treatment has been discussed in terms of providing technology which makes it possible to achieve *any* degree of waste treatment desired, in fact, to return a waste water to a quality at least as high as that of the water before use. The following illustrates some additional areas for research and development under that category:

1. Improved procedures to accomplish more effective operation of plants.
2. Methods for increasing the capacity and performance of existing plants.
3. Improved design and constructing procedures, including materials of construction.
4. Treatment plants which would occupy a minimum of land area.
5. New systems for combining the waste treatment-water purification steps of the water cycle.
6. Treatment systems which would result in valuable by-products.

SCIENTIFIC AND TECHNICAL BASES FOR WATER QUALITY STANDARDS

The identification of pollutants, the source of pollutants, and the fate-persistence of pollutants in the water environment require the application and development of scientific and technical instrumentation, relationships, methods, analyses, and techniques.

The criteria for measuring the quality of water for various uses and the relationships between those criteria and effects on water use have to be established (Water quality requirements—Subprogram 18—Figure 1). It would be most desirable to have data on the effects of different concentrations of pollutants (or deleterious results produced by pollutants) related to the time of exposure. This concept can be reviewed by examination of Figure 2. The complete set of data would result in a series of curves indicating biological, economic, and aesthetic effects on a short or long term basis. The complexities associated with biological and ecological systems, the synergistic and antagonistic relationships among pollutants, and quantification of aesthetic factors all may be found in this area of research.

The development of treatment processes and pollution control techniques and the determination of the capital and operating costs associated with those systems is another major area for Research and Development and Demonstration. The results of this effort may be illustrated by a series of curves—Figure 3, which would prevent the costs of reducing the concentration of any pollutant (having an initial concentration of C_1, C_2, C_3, etc.) to any desired residual level. The total pollutional load from any pollutant may be obtained by relating concentration to flow or volume of wastes.

The scientific and technical data and information which could be presented in a form as illustrated by Figures 2 and 3, would enable the water quality control administrator to know the costs of achieving or protecting any water use. The gathering of that data and information has top priority in the research and development effort of FWPCA. Considerably more data than currently available are needed.

We have had no experience to date in the enforcement of violations of established water quality standards for interstate waters. The standards submissions, including their plans of implementation and enforcement, of 15 States have been approved and are Federally enforceable. The range of expert scientific and techical competence recruited to assist in the development of water quality standards, as represented most notably by the 84 scientists and water authorities comprising the National Technical Advisory Committee to the Federal Water Pollution Control Administration on Water Quality Criteria, provides substantial weight and support, technical and legal, to the established standards if challenged in this regard.

ADVANCED WASTE TREATMENT—RECENT PROGRESS AND STATUS

Research and development on advanced waste treatment (AWT) technology was begun, on a very modest scale, in 1961. The objective of this program is to develop and demonstrate the technology necessary to achieve, at minimum cost, any level of waste treatment which may be required to meet pollution control needs. The methods being developed range across the spectrum of physical, chemical, and biological separation techniques. They range from the mundane (filtration and sedimentation), through the novel (biological denitrification), to the exotic (reverse osmosis). Techniques are under study to improve the performance of primary treatment, to upgrade and extend the capability of secondary treatment, and to extend the purification train on to tertiary treatment.

The pollutants to be removed or destroyed in waste treatment may be generally categorized as:

(1) suspended and colloidal solids
(2) dissolved biodegradable organics
(3) dissolved refractory organics
(4) nutrients
(5) inorganic salts
(6) microorganisms

Many processes are, of course, capable of treating wastes in more than one category; others may be effective for only one type. Likewise, pollution control needs vary from location to location. Considerable effort is being expended, therefore, in developing optimized "systems" of processes which will meet whatever localized requirement may be specified. This research is being carried out both by in-house scientists and engineers of FWPCA and through contracts and grants with outside organizations. As with any "process development" program, effort normally starts at the desk or in the exploratory laboratory. With successful results, the development then moves to bench-scale or bread-board studies and thence to the pilot plant, the field evaluation, and ultimately to full-scale demonstration.

Within the last year or two, substantial progress has been made in moving a number of AWT processes well along in the above process development sequence. In total, some 60 separation or ultimate disposal processes have been evaluated. Approximately 25 percent have been rejected for technical or economic reasons; another quarter are undergoing laboratory or bench-scale study, almost a third are at the pilot-scale; and the remainder, some dozen processes, are now being field evaluated or actually demonstrated. Examples of progress within the last 12–18 months include the following:

a. A joint study with the City of Los Angeles to evaluate improved operational methods for the activated sludge process is scheduled to begin this month.

b. A 7.5 mgd demonstration plant including granular activated carbon adsorption, ammonia stripping, lime coagulation and precipitation of phosphates, multi-media filtration, absorbate incincerations, lime recalcination and recovery, and disinfection is under construction and nearing completion.

c. Cost of the granular activated carbon adsorption process for achieving 98–99% removal of organic pollutants from secondary sewage effluent was reduced by 20% to an estimated 8.3¢/1000 gal. (at 10 mgd plant size.)

d. A new method for high-efficiency removal of phosphates from municipal wastes through addition of small amounts of chemicals has been developed and proven effective in bench-scale tests. Preliminary tests at 2 full-scale waste treatment plants were completed with promising results.

e. Solutions have been found to the serious membrane fouling problems which have been prevalent in electrodialysis treatment of wastewater. Pilot-scale verification of these techniques is now underway.

f. Pilot plant studies of the powdered activated carbon adsorption process have shown high quality, reliable performance and give promise that this technique for refractory organic removal may be lower in cost than granular carbon adsorption. Very recent results indicate that the process might even be a substitute for conventional biological secondary treatment.

g. Consistent biological nitrification-denitrification has been achieved in bench-scale studies of a new type two-stage biological process. It has been discovered that effective denitrification can also be achieved through use of a feed supplemented packed column contracter.

h. The existence of a high efficiency phosphate removal phenomenon within certain existing activated sludge plants was brought to light. Some controlling variables have been established, others are now being confirmed.

i. The effectiveness of organic polyelectrolytes as additives in primary treatment was demonstrated in a full-scale plant.

j. Pilot-scale studies of several types of reverse osmosis equipment have been initiated.

k. The technical feasibility of two new oxidation processes, involving ozone and light-catalyzed chlorine, was established.

l. Anion exchange resins were found to be effective in removing up to 50% of the soluble organics from secondary effluents without irreversible fouling.

m. A comprehensive summary of capital and operating costs for both conventional and advanced waste treatment processes has been completed.

n. Studies of various methods for powdered carbon regeneration were initiated. Preliminary results are quite promising.

o. To predict and control the performance of waste treatment processes by computer, mathematical models for these processes are being formulated. A preliminary model for the activated sludge process was completed.

p. Arrangements have been made for field evaluation of pipelining and surface spreading of digested sludges to revegetate and reclaim disturbed land areas such as strip mines and to reduce acid mine drainage pollution from these areas.

q. A technique for recovering and reusing chemical precipitants used in treatment for phosphate removal has been evaluated. The technique may lead to significant cost reductions for phosphate removal.

r. Exploratory research has shown that the hydrolysis of sewage sludge can recover amino acids and other dissolved nutrients which may be usable as a by-product from sludge disposal operations.

ACCOMPLISHMENTS IN INDUSTRIAL POLLUTION CONTROL PROGRAM

During FY 1967, studies were initiated to identify and analyze the problem areas and determine the status of treatment and control technology in selected industries. In addition, a major new program for industrial waste pollution control (authorized by Section 6(b) of the 1966 Act) was implemented. Under this authority, 10 grant projects amounting to $2.6 million in grants were awarded. These included eight full-scale demonstration facilities on control of pollution from industries in the fields of pulp and paper, meat-packing, potato and sugar beet processing, citrus fruit, etc. The ongoing FY 68 program currently has research and demonstration grants covering representative industrial pollution from such other major sources as metal and metal products, leather and tanning, chemical and allied products, etc. These grants now cover representative industrial pollution from sources encompassing a combined total of three-fourths the entire industrial pollution load in terms of volume and biochemical oxygen demand. This program through FY 69 also includes the top priority projects which resulted from the FWPCA studies on immediate needs for the river basins.

It is anticipated that approximately 25 grants will be awarded in FY 68, which will include new and novel physical, chemical and biological treatment processes for abatement of pollution from industrial sources.

National organizations, representative of the various manufactures, i.e., API, National Canners Association, TAPPI, National Metal Finishers Association, etc., have been contacted and their key committees on water pollution problems are being utilized to provide the required guidance on a program of mutual concern.

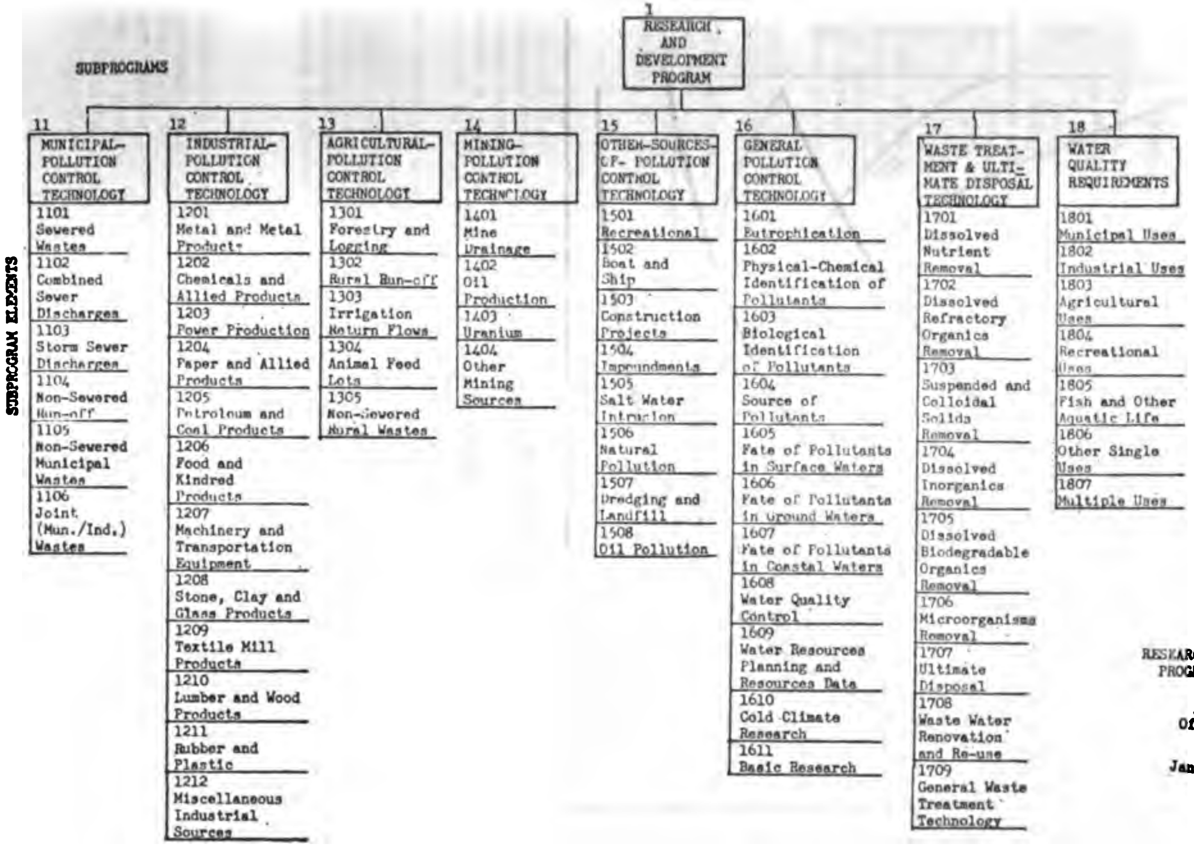
EUTROPHICATION

The complex problem of establishing the relationships between water pollution and the undesirable effects of eutrophication (enrichment) of lakes, streams, and estuaries is being attacked with increased effort. A joint government-industry task force to recommend a cooperative research program has been established. This task force has recently announced that it will attempt to develop a standardized procedure to determine the algal growth potential (AGP) of various chemicals and waters.

The proposed procedure would be designed to: (1) anticipate the effect on algal production of introducing various nutrients; (2) determine the extent to which nutrient levels must be reduced in a body of water to remedy eutrophication; (3) determine at what point along the time scale of progressing eutrophication a body of water lies; (4) evaluate the effectiveness of waste treatment processes in removing elements that support or stimulate the growth of algae; and (5) be adaptable for special problem purposes.

WATER QUALITY CRITERIA AND USE OF WATER

There have been a number of beneficial uses of water identified, including: public water suppliers; industrial water supplies; agricultural water supplies; fish, other aquatic life and wildlife; and recreation and aesthetics. For each of these uses, water quality criteria have been identified and selected. The reports of "National Advisory Committee on Water Quality Criteria to the Secretary of the Interior, June 30, 1967," and "Water Quality Criteria" by McKee and Wolf in 1963, contain the most complete information on water quality criteria as related to water uses.


SUBPROGRAMS
SUBPROGRAM ELEMENTS
1 RESEARCH AND DEVELOPMENT PROGRAM
11 MUNICIPAL-POLLUTION CONTROL TECHNOLOGY
1101 Sewered Wastes
1102 Combined Sewer Discharges
1103 Storm Sewer Discharges
1104 Non-Sewered Run-off
1105 Non-Sewered Municipal Wastes
1106 Joint (Mun./Ind.) Wastes
12 INDUSTRIAL-POLLUTION CONTROL TECHNOLOGY
1201 Metal and Metal Products
1202 Chemicals and Allied Products
1203 Power Production
1204 Paper and Allied Products
1205 Petroleum and Coal Products
1206 Food and Kindred Products
1207 Machinery and Transportation Equipment
1208 Stone, Clay and Glass Products
1209 Textile Mill Products
1210 Lumber and Wood Products
1211 Rubber and Plastic
1212 Miscellaneous Industrial Sources
13 AGRICULTURAL-POLLUTION CONTROL TECHNOLOGY
1301 Forestry and Logging
1302 Rural Run-off
1303 Irrigation Return Flows
1304 Animal Feed Lots
1305 Non-Sewered Rural Wastes
14 MINING-POLLUTION CONTROL TECHNOLOGY
1401 Mine Drainage
1402 Oil Production
1403 Uranium
1404 Other Mining Sources
15 OTHER-SOURCES-OF- POLLUTION CONTROL TECHNOLOGY
1501 Recreational
1502 Boat and Ship
1503 Construction Projects
1504 Impoundments
1505 Salt Water Intrusion
1506 Natural Pollution
1507 Dredging and Landfill
1508 Oil Pollution
16 GENERAL POLLUTION CONTROL TECHNOLOGY
1601 Eutrophication
1602 Physical-Chemical Identification of Pollutants
1603 Biological Identification of Pollutants
1604 Source of Pollutants
1605 Fate of Pollutants in Surface Waters
1606 Fate of Pollutants in Ground Waters
1607 Fate of Pollutants in Coastal Waters
1608 Water Quality Control
1609 Water Resources Planning and Resources Data
1610 Cold Climate Research
1611 Basic Research
17 WASTE TREATMENT & ULTIMATE DISPOSAL TECHNOLOGY
1701 Dissolved Nutrient Removal
1702 Dissolved Refractory Organics Removal
1703 Suspended and Colloidal Solids Removal
1704 Dissolved Inorganics Removal
1705 Dissolved Biodegradable Organics Removal
1706 Microorganisms Removal
1707 Ultimate Disposal
1708 Waste Water Renovation and Re-use
1709 General Waste Treatment Technology
18 WATER QUALITY REQUIREMENTS
1801 Municipal Uses
1802 Industrial Uses
1803 Agricultural Uses
1804 Recreational Uses
1805 Fish and Other Aquatic Life
1806 Other Single Uses
1807 Multiple Uses

RESEARCH AND DEVELOPMENT
PROGRAM STRUCTURE

Office of R&D
FWPCA

January 12, 1968

FIGURE 1

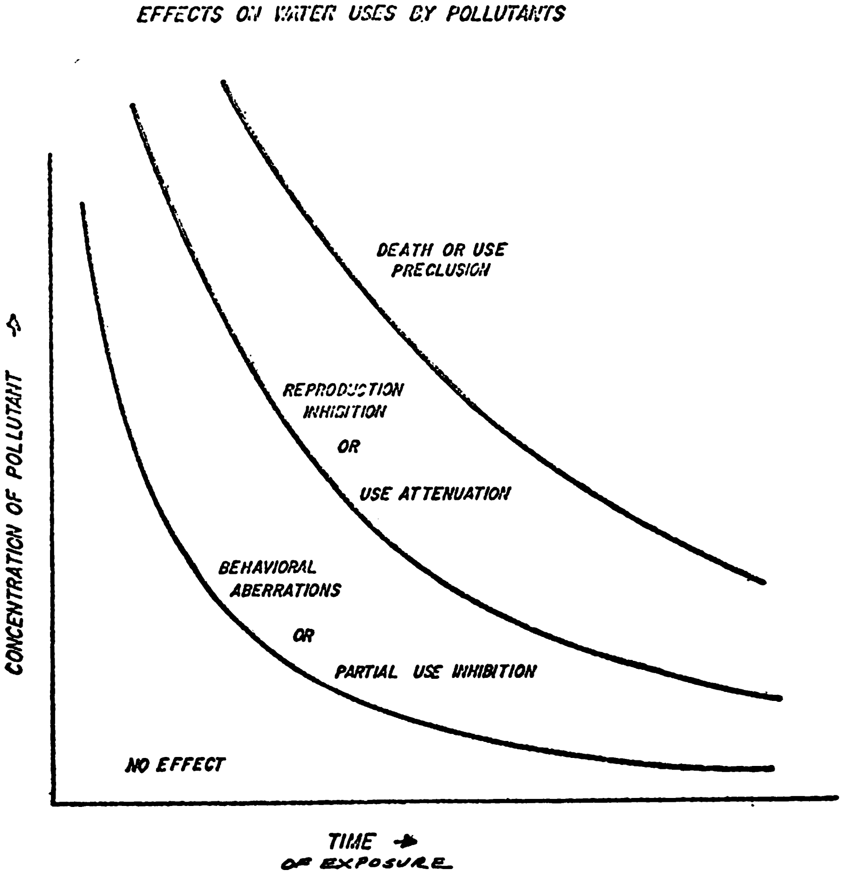

EFFECTS ON WATER USES BY POLLUTANTS
DEATH OR USE PRECLUSION
REPRODUCTION INHIBITION
OR
USE ATTENUATION
BEHAVIORAL ABERRATIONS
OR
PARTIAL USE INHIBITION
NO EFFECT
CONCENTRATION OF POLLUTANT →
TIME → OF EXPOSURE

Figure 2

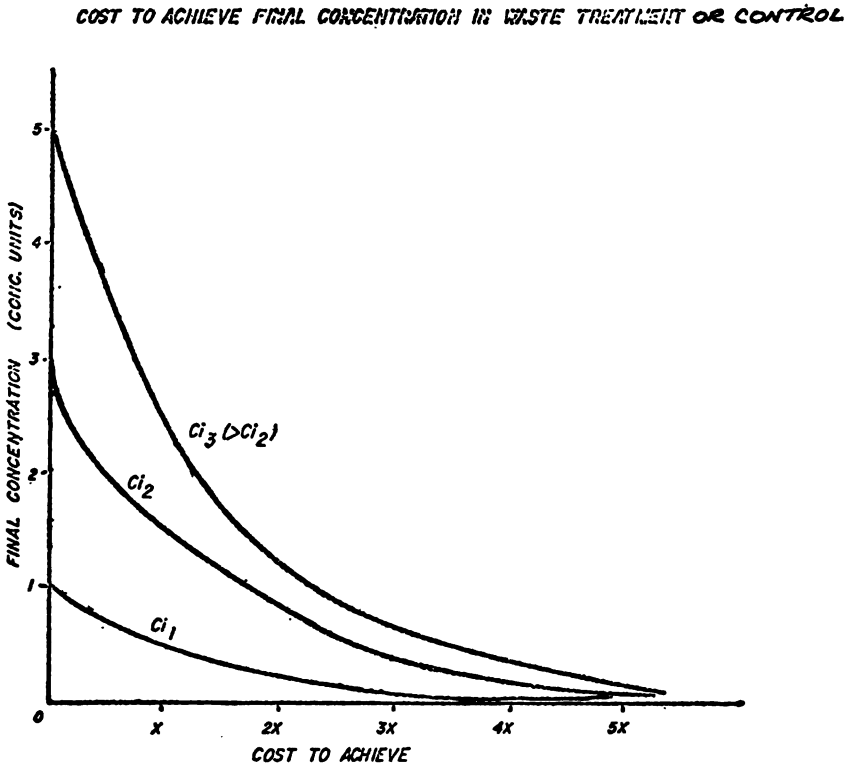

COST TO ACHIEVE FINAL CONCENTRATION IN WASTE TREATMENT OR CONTROL
FINAL CONCENTRATION (CONC. UNITS)
5
4
3
2
1
0
Ci_3 (>Ci_2)
Ci_2
Ci_1
X
2X
3X
4X
5X
COST TO ACHIEVE

FIGURE 3

Mr. Daddario. We appreciate your statement and your cooperation. Mr. Chairman?

Chairman Miller. Doctor, I wonder if you are familiar with a vexatious problem that confronts the Livermore Valley in California. That is where the Lawrence Laboratory or the big laboratory is located. It is an interior basin due to seismic eruptions, cut off of the natural flow, particularly underground water out of this basin, so that the storage capacity underground is around 500,000 acre-feet.

That is one of the things that makes the area a fine winegrowing area and a lot of other things. In the meantime, the city of Livermore at one time had about 3,500 people and now has about 30,000. The usual problem of sewage disposal came up.

Alameda Creek drains this. As you know, in the west we get all of the rain and the runoff in certain seasons of the year. The rest of year the creek is nearly dry. They proceeded to do the things that we did some years ago. We said we have treated this effluent. It is sterile. So we will dump it into the creek. The wells in the city of San Francisco have the prior right to this underground water. They began to get traces of detergent in some of this effluent. It might be hard enough to clean the big lake, but how are you going to clean up an underground supply of water?

Suffice to say this has been stopped now.

Dr. Weinberger. The Chairman raises, of course, a very important question about some of the long-range effects or the effects which may only be noticeable in the future to make sure we take appropriate steps at an early time.

Contamination of ground water, of course, is particularly critical because of the long period of time that it does take to purify it or clean it. I might say that we do have a project in California east of Los Angeles, which is also a restricted basin. But there, by proper treatment of wastes, by using the best technology which we have, they will be taking their waste water and deliberately putting it back into the ground to recharge. We do not anticipate any problems.

Chairman Miller. I think if you treated the water when you let the effluent itself get in there, seep underground, this is another thing. A very distinguished scientist, one Athelstan Spilhaus, told me long ago the best thing we could do was to start teaching the people of the United States they had to use reconstituted water. This seems very repugnant, but it is being done now in certain parts of the country and we don't know it. It is something we have to do. These are going to create greater problems.

The discharge from the condensers that were used to produce heat at Richland, Wash., were in no way contaminated. It was only heated and put into the Columbia River, but it changed the ecology of that river so far as salmon are concerned. The migrating salmon coming upstream expect to find a certain temperature of water and found it 3° or 4° higher. They just refuse to go through with their natural process. So we can lose things in this way, too.

Mr. Fulton. Mr. Chairman?

Mr. Daddario. Are you finished?

Chairman Miller. Yes.

Mr. Fulton. I wanted to compliment the chairman. I thought they were good, specific questions of the effects of actions that are taken for one purpose and result in a whole generation of things that cause results later.

I am interested in the chairman's use of the word "effluent" because it is the problem of affluence and effluence that causes these troubles.

Somebody tried to explain to me the possible difference between reverse osmosis and retro osmosis. If you would like to take a chance at that sometime, I would like to see it in the record.

We are getting into a field where it is entirely new language, which is what I am pointing out.

Dr. **Weinberger.** A personal note. I certainly appreciate the opportunity of being here. I must say it is always a very stimulating experience, and I mean it very sincerely.

Mr. **Daddario.** We will not trouble you further this morning, Dr. Weinberger, but I do think we can proceed later and perhaps get some of these statements into the record.

We, therefore, will continue with Dr. Pecora.

STATEMENT OF DR. W. T. PECORA, DIRECTOR, GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR; ACCOMPANIED BY FRANK CLARKE, ASSISTANT DIRECTOR FOR ENGINEERING

Dr. **Pecora.** Mr. Chairman, as Director of the U.S. Geological Survey, I appear before you merely to emphasize the fact that ours is an old-line agency that has been gathering, acquiring information and data for almost 90 years and making it available to all users, planners, and managers of our earth's resources.

Among the resources, of course, water is our principal concern. With the permission of the Chair, may I introduce into the record my prepared statement and then use some highlights from it with the thought of saving time that is available for this session.

In the process of acquiring information and data for general use, one needs to have a whole series of continuing recording stations and in this direction we have somewhat in the order of 8,000 recording stations for quality and quantity of surface waters, and something like 15,000 observation wells for the ground water.

Mr. **Daddario.** Dr. Pecora, we can assume that we have many of our streams properly monitored? What do these figures in fact mean?

Because we have so many, it sounds as though we are doing a good monitoring job. Are we or aren't we?

Dr. **Pecora.** Let me evaluate that for the committee. With the background information acquired over several decades we have an excellent record in many places throughout the country of the variation and the norm that are to be expected in certain streams. We are nowhere near a satisfactory status. We are planning additional monitoring stations because of the changes that are taking place through population explosion in many areas of the country.

One must always think in terms of a frame of reference. For example, we have instituted a program of benchmark stations in areas that are almost completely free from human effects to determine the change in time at such stations, this serves as a frame of reference. In areas of urban expansion or in the stress areas, in suburbia or rurbia, our aim is to develop a background frame of data so the changes in time will be recorded. It is the trend that is important. It is the accumulation of the basic figures that one needs to refer to continually before he can make decisions.

Mr. **Daddario**. You have referred to water as a resource. We talk about monitoring and the way criteria are established. Do you consider that we should also include air as a resource? Would you put that separately?

Dr. **Pecora**. I would claim air as one of our most valuable resources for man and other living things on earth. Our organization does not work in that environment. We are in the soldid earth sciences area.

Speaking of water in the solid earth science area, we normally think of water in the visible state—that which we can see and measure at the surface and remeasure and analyze and reanalyze.

There is a second area of water called the invisible water which we refer to in our profession as the ground water. I think this is much more important than perhaps is realized by most people. There is a constant interaction of the water locked up in the porous and permeable rocks of the earth, a constant interaction of this water supply with the streams. Streamflow basically depends on this continuing ground water supply. Constant loss of this water in the coastal areas through underground flow also occurs. We are very much concerned in not only the quantity of water that is available to man but in the quality of water needed for many purposes. As a third party information sources for all users, managers, and planners, we have developed a system of evaluating the resource in its entirety both quality and quantity, in its various environments.

Mr. **Daddario**. Have we identified or are we capable of identifying these ground water streams, as you put it, so that we can come to some judgment about them?

Dr. **Pecora**. We are far behind in the knowledge that we need for future best management of this invisible ground water—far behind in the knowledge we need in order to add another reliable resource for use of man. Many countries of the world have no real concept of the great potential of ground water.

In the Eastern States, for example, the Congress has just authorized an interstate study of ground water in Delmarva, involving the three States of Delaware, Maryland, and Virginia.

In the gulf coast region there are 13 States greatly concerned with future supplies of ground water. In the High Plains region there are many States east of the Rocky Mountains that require additional knowledge of ground water. These are parts of the whole problem.

To do anything that would pollute this potential supply of water is a grevious fault on the part of man. In this direction we need to acquire many kinds of information, you see, that can go into the decision-making processes of planners, users, and managers.

Mr. **Daddario**. Dr. Pecora, we are beginning to establish criteria based on the importance of this ground water resource without having a good idea what we in fact have. My question gets back to how do we really know what we are dealing with?

Dr. **Pecora**. We know on the basis of decades of work that there is an hydrodynamic pattern of water flow from rain and seepage to the underground. We would need to develop knowledge of ground water in greater detail so it can be a continuing factor in management.

In direct response to your question, Mr. Chairman, we know much. We don't know enough. We are moving in the direction of learning more.

Mr. **Daddario**. You are talking about vast amounts of water which in fact amount to a very valuable resource, which we know very little about?

Dr. **Pecora**. Yes. I think the point that I should make is that we have the potential now of making an overall survey of the value of this invisible supply of water.

Mr. **Daddario**. You have the potential which means the capability. Do you have enough money to do it?

Dr. **Pecora**. Talent, I think, is more important than money at this time in this subject area. This may surprise some Members of Congress to hear this kind of a statement.

Mr. **Daddario**. No; it does not. We find the manpower situation is the reason we sometimes have a problem. We were not able to anticipate the need or deal with it in advance.

Dr. **Pecora**. Yes.

A few decades ago our group in the Geological Survey developed what we call the science of underground hydrology. We have been working with the universities to help develop new talent in the subject area as well as with our international associates.

We feel this is an area of great possibility and potential for the people on this earth. We intend to push in the direction of acquisition of more and better information about the ground water supply so that this resource can be integrated properly with the surface water supply in all management decisions.

Mr. **Daddario**. I had assumed when you said you had the potential to do this that you had the manpower to do it. Your statement then is that we have the potential and the background knowledge, but we need to develop manpower and support in order to get this job done. You believe it valuable enough so that we do this?

Dr. **Pecora**. That is exactly it; we need to develop more talent in order to do more of this kind of work, and we are capable of doing this.

Mr. **Fulton**. Mr. Chairman.

Mr. **Daddario**. Mr. Fulton.

Mr. **Fulton**. Do you look into the question of the water table and ground-water pollution in your work?

Dr. **Pecora**. Yes. This is part of our general jurisdiction, the monitoring of the quality of water in all of its locations. It is a rather important part of our work.

Mr. **Fulton**. Why should you and Dr. Weinberger not be working in the same shop?

Dr. **Pecora**. We are both in the Department of Interior.

Mr. **Fulton**. Yes; but I said why is it divided in the Department of Interior?

Dr. **Pecora**. May I refer to the national water data coördination effort which was set up through the Bureau of the Budget Circular A-67, a well-known circular among water users. The acquisition of water data and its storage in a computer system for general output is a joint effort between the Federal Water Pollution Control Administration, Geological Survey, and other agencies. We have been given the obligation of developing this on a joint-use basis. There is much closer collaboration than perhaps is indicated by the inquiry.

Mr. **Fulton.** I was interested in the number of wells you are drilling and the progress you are making, but I wondered if you also use a divining rod in your agency or a forked peach branch.

Dr. **Pecora.** I can say for the record that we do not.

Mr. **Fulton.** Might I assist you on your word "creation" because I am interested in it. Where you had changed suburbia to "rurbia" I think all you have to do is put an extra "r" in and have "subrurbia."

That is all.

Dr. **Pecora.** I merely wanted to introduce these comments into the record. I know we are short of time.

Mr. **Daddario.** Dr. Pecora, I appreciate that. I assume you are available if we have any additional questions.

Dr. **Pecora.** At all times, sir.

(Dr. Pecora's complete statement follows:)

PREPARED STATEMENT BY W. T. PECORA, DIRECTOR, U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR, ON THE BUREAU'S RESEARCH AND DATA-COLLECTION PROGRAM

The Geological Survey has a long-standing responsibility for studies of the earth's physical features and resources. The object of this work is to provide reliable information on existing conditions and to generate sufficient knowledge of chemical, physical, and biological processes that one can determine changes likely to occur under a variety of environmental stresses, including those imposed by man. This in turn is aimed at providing reliable information for use by others in wise management of natural resources. In studies of this kind one must consider the earth's topography, geologic structure, and mineral components because they undergo a variety of interactions which are sensitive to, and have a bearing upon the behavior of living things.

Collection of basic data on water resources and research for improvement of ability to collect and interpret these data constitute a major part of the Survey's scientific program. This is an important aspect of the Nation's pollution-control program because it documents present conditions (for example, temperature patterns) and indicates the direction and extent of change. At the present time there are more than 3,000 Survey people engaged in the study of water resources. Measurements of quality and equally important quantitative measurements are made at 8,000 surface-water sampling sites on schedules ranging from monthly checks to continuous monitoring. Similar qualitative and quantitative measurements are made on 15,000 observation wells scattered over the 50 states. Seventeen district and regional Survey laboratories perform water analyses on a continuing basis. Plans already have been completed for increasing the number of basic network sampling points by 50% within 5 years and for adding 150 new multiparameter, automatic monitors to the 160 in operation for better sensing of points particularly important to water managers. A plan has been developed jointly with the Federal Water Pollution Control Administration for combining the Survey's general purpose water data and the Administration's special purpose data in a single master data bank and computer readout system. This will make all information immediately available in uniform style to those who need it for control of pollution problems and other water management operations. During the past year great emphasis has been placed on faster and better collection transmission and readout of water data. With the help of teletransmission and master computer facilities recently installed we expect that most of the Survey's data will be available to local users and from master data centers on weekly or more frequent bases before the end of another fiscal year.

The Survey's Water Resources Division aims much of its research effort at improvement of water data. Well-staffed analytical research laboratories in Washington, D.C., Denver, Colorado, and Menlo Park, California concentrate on developing analytical methods and related equipment. Together with district and cooperating laboratories they conduct continuing analytical reference and methods standardization studies to insure maximum practicable reliability and uniformity of results. Similar research is underway on improving data network design, methods of data transmission, and data processing. Both inhouse and extramural research is done on data sensitivity to determine what kinds of data must be collected, how often, and at what points to serve the greatest need at the lowest cost. This program also includes research on improved methods of extrapolation and interpolation from point samples to ungaged points in space and time. A new and highly important research project has been started to develop better methods for collecting water data in urban environments, and a significant start has been made on identification of ecological indicators of stream health.

Remote sensing techniques are being perfected for faster coverage of water resources of larger areas. Airborne radiometers and infrared scanners already are providing useful data on thermal patterns in surface waters, and considerable progress is being made in detecting other pollutants by selective band photography. Lesser equipment offers considerable promise as a quantitative and perhaps a semiquantitative tool for analyzing polluted waters from an aircraft or space platform. Plans already are under way for data satellites with land-based computers capable of reading out synoptic information on a global, time-lapse basis for many factors which bear upon pollution problems. These include effects of changing land use and urbanization on flow and quality of rivers, cyclic quality patterns in lakes and ponds, and evidence of progressive degradation in surface waters.

In addition to the comprehensive programs of basic data collection and data improvement research, the Survey has a sizeable effort in fundamental and applied hydrological research aimed at better understanding of the origin, movement and fates of pollutants. Hydrodynamic research on rivers and estuaries already has produced a two-dimensional mathematical model capable of predicting flow patterns at any point on a water body using data collected from any other point. Similar three-dimensional models are being developed. Hydrodynamic work on lakes started during last fiscal year is expected to produce very useful information on dispersion patterns and to simplify tracing of troublesome pollutants. Survey researchers have played and are continuing to play a lead role in studies of heat dissipation from lakes and ponds, including cooling ponds, and of thermal die-away patterns from point heat sources in rivers. A very significant pilot study is underway on ecological responses of a major estuary to abnormal waste heat loads from a power plant.

Other principal areas of our research closely related to the pollution problem are mechanics of sediment dispersion, transport, and deposition; movement of water and waste materials in the unsaturated soil zone and ground-water systems; practicability and effects of artificial recharge with waste water; processes and problems related to storage of liquid wastes underground, and geochemical controls of water quality in troublesome processes such as mine-acid generation, euthrophication and leaching of solid waste dumps. In recent years there has been increasing emphasis on fates of pollutants in underground systems because of the trend toward more underground waste disposal and the recognized difficulty of purging underground fresh waters once they are accidentally contaminated. Increasing attention also has been paid to the movements and fates of pesticides and other troublesome synthetics. The overall cost of Survey research related either directly or indirectly to pollution problems, is approximately $12 million per year. Each year the work generates 300 to 400 Professional Papers, Water-Supply Papers and journal articles available to many users.

Multidiscipline capability has proved to be of considerable help to the Survey in conducting research of the kinds described above. Knowledge of geology and geochemistry simplify research on behavior of pollutants in surface water and ground water. Expertise in topographic studies helps in predicting flows of surface water which have a marked bearing on the behavior of and impact of water contaminants. Knowledge of geomorphology and geography allows one to understand sediment transport phenomena and related problems. Because of this interaction of disciplines it is fair to say the Survey's entire staff of approximately 9,000 contribute significantly to the subjects discussed above and therewith to the solution of environmental pollution problems

The need for better information on water quality despite limited funding has led to increasing effort on improved programming of the Survey's water studies. The Office of Water Data Coordination, established under Bureau of the Budget Circular A–67, confers with federal and nonfederal data users annually to determine what new data and data systems deserve priority attention. Comprehensive status reports of all Survey research are studied carefully several times each year to determine what work is contributing significantly to major environmental problems and to redirect effort as appropriate. The Headquarters staff of the Water Resources Division now includes a well-staffed program office and a systems analysis laboratory which devote full time to assessment of needs in basic data and research and to development of the programs and pilot studies needed to fulfill them.

The Survey heartily endorses the thesis of this Committee that more research effort must be concentrated on pollution problems. In doing this we think that one must recognize the importance not only of corrective research, such as the highly important work on water reuse and advanced waste treatment, but be equally conscious of, and attentive to, baffling scientific questions which must be answered if there is to be proper understanding for preventive as well as corrective treatment. At present, far too little is known about phosphate chemistry in the natural environment to allow one to assess its effects in euthrophication, or to eliminate whatever undesirable contribution it is making. As the Committee already has observed, we still cannot read ecological danger signals far enough in advance to take proper inhibitive action in processes of this kind. Many aspects of mine-acid generation still are poorly understood and no one is properly prepared to recharge water or liquid wastes into complex underground systems with certainty of the results that such an operation may yield.

In addition to upgrading our knowledge of the fundamental science related to pollution problems, we believe there must be continuing emphasis on upgrading of data systems and on ability to test significance of and interpret water data. Neglecting these subjects is likely to result in our continuing to overlook the relatively simple solutions.

The Committee's interest in intensified research on water-quality problems is timely, well-oriented and of special concern to the Geological Survey. We are eager to play our proper role in collecting the data and to cooperate in the research needed to provide the best quality of our water resources. We recognize the needs highlighted by the Committee's action and we are tooling up as rapidly as possible under unavoidable restraints to get on with the job.

Mr. Daddario. We have Mr. Everts here, who has come from Cincinnati. We apologize for keeping you so long, and yet this is the situation we are in. We would appreciate if you could summarize your statement, Mr. Everts, and then we will see where we go from there.

Mr. Fulton. Would you, before we start with Mr. Everts, Dr. Pecora, give us a statement for the record on the water table and ground water pollution?

Dr. Pecora. We certainly will.

(The information requested is as follows:)

In most of the Nation, there still is neither serious depletion nor serious pollution of ground water. However, certain local and regional problems warn that substantially more effort must be made to identify and quantify ground water.

In areas not yet affected by heavy ground-water pumping, any temporary change in the water table resulting from man's early development of the land has reached a state of dynamic balance and is not cause for concern. In other words, there is no progressive depletion of ground water in lightly pumped regions. The water table fluctuates normally with climate, season, and years as in the recent Northeastern drought. Naturally induced trends may persist for years before recovery, and sufficient knowledge of such cycling must be available to avert undesirable consequences.

In some pumped area, ground-water levels have been lowered substantially without developing serious problems. For example, ground-water levels near Memphis, Tennessee, have declined persistently for years as withdrawals for municipal, industrial, and agricultural uses have increased. This still is not considered to be an area of troublesome depletion, but, of course, pumping costs have increased because of greater pumping depth.

Depletion in the sense of withdrawal from storage greatly in excess of anticipated natural replenishment has occurred in many small areas scattered over the country, but in only a few large areas and regions. Outstanding examples are the southern High Plains of Texas and New Mexico, north-central Arizona (the Cental Arizona Project area), large areas of the San Joaquin Valley of California's Central Valley, and a substantial number of smaller alluvial valleys in California, Arizona, New Mexico, and locally elsewhere. In all these areas, the depletion is sufficiently severe that plans and projects to ameliorate its effects are in various stages of progress.

Pollution of ground water still is primarily a local problem, but some relatively large and important areas have been affected. Several million spectic tanks and other types of industrial sewage disposal systems serve as point sources of potential pollution to nearby water wells. Relatively few examples of such pollution have occurred in the vicinity of Norfolk, Va., and Anoka, Minn., because of the peculiar character of the soil in these areas. Disposal of a variety of domestic, municipal and industrial wastes in wells and ponds also have caused significant local problems. Typical ones have occurred in limestone ground water systems of Ohio and Florida, as well as in other types of rock in Colorado and Chesapeake Bay area of Maryland. Fortunately, such situations are receiving increasing attention. Hopefully the time is approaching when large quantities of polluted material cannot be dumped into the ground without considerable thought being given to possible consequences. Data of the kind collected by the Geological Survey is essential to such thinking.

Encroachment of sea water in coastal areas is a form of pollution which has occurred in numerous parts of the country including Long Island, New York, Florida, Texas, and California. Most of these situations are under study and plans for remedies are more or less advanced. Creation of a fresh water barrier by installing artificial recharge wells along the coast near Los Angeles, and pilot recharge wells in Long Island are aimed at correcting situations of this kind.

The U.S. Geological Survey uses thousands of test wells and some hundreds of federal and nonfederal cooperators in watching for significant changes in the quantity and quality of ground waters. We conduct extensive research on movement of ground water and ground water contaminants, as well as on the effects of wastes discharged underground in order to predict what changes are likely to occur. In collecting ground water information, as in collecting surface water information, the Survey plays a long-standing third part role in producing objective data which are not influenced or restricted by any management or control responsibility. These are made available quickly and without reservation through the master data system of the Department of the Interior, operated by the Geological Survey, not only to the Water Pollution Control Administration, but to all others who have need for them.

Mr. DADDARIO. Mr. Everts.

(Mr. Everts' biography follows:)

CURTISS M. EVERTS

Position: Chief, Water Supply and Sea Resources Program, National Center for Urban and Industrial Health, Bureau of Disease Prevention and Environmental Control, Public Health Service, U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio 45202.

Birthplace and date: Houston, Texas, Oct. 7, 1908.

Education: Texas A. & M. College, 1926–30, BS (Civil Engineering) 1930; Harvard University, 1938–39, MSE (Sanitary Engineering) 1939.

Experience: Public Health Service, U.S. DHEW:

Chief, Water Supply and Sea Resources Program, National Center for Urban and Industrial Health, Cincinnati, Ohio 45202, Aug. 1967 to present.

Regional Program Director, Solid Wastes Program, National Center for Urban and Industrial Health, San Francisco, California, Sept. 1966, July 1967.

Director, Pacific Northwest Water Laboratory, Corvallis, Oregon, Sept. 1963, Sept. 1966.

Oregon State Air Pollution Authority, Secretary and Chief Engineer, 1961–63.

Oregon State Sanitary Authority, Secretary and Chief Engineer, 1941–63.
Oregon State Board of Health, Principal Asst. Sanitary Engineer, 1936–41.
Texas State Board of Health, Utah State Board of Health, Asst. State Director, Oregon State Board of Health of Community Sanitation, 1934–36.
Texas State Board of Health, District Sanitary Engineer, 1931–34.
City of Colorado City, Texas, City Sanitary Engineer, 1930–31.

ASSOCIATION MEMBERSHIPS

Member, American Water Works Association
Member, American Public Health Association
Member, Western Branch, American Public Health Association (President 1953–54)
Member, Oregon Public Health Association (President 1947–48)
Member, Pacific Northwest Pollution Control Association (President 1952–53)
Member, Conference of State Sanitary Engineers 1941–63 (Chairman 1951–52)
Member, State and Interstate Water Pollution Control Administrators 1958–63 (Chairman 1958–60)
Diplomat, American Academy of Sanitary Engineering

STATEMENT OF CURTISS EVERTS, CHIEF, WATER SUPPLY AND SEA RESOURCES PROGRAM, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. EVERTS. Mr. Chairman and members of the committee, I appreciate the opportunity of appearing before you to present some of the highlights of the Public Health Service effort in the field of water supply.

The interest of the Public Health Service in the problems of water supply and its relations to health began in 1912 with the enactment of Public Law 410. These statutes authorized the Surgeon General to conduct research investigations and studies related to the cause and prevention of diseases and impairments of man; to make and enforce certain public health regulations including those relating to the prevention of the interstate spread of communicable diseases; and accept assistance from and to assist States in obtaining compliance with regulations, as well as to control and prevent disease.

The Interstate Quarantine Regulations and the Public Health Service Drinking Water Standards were promulgated pursuant to such authorization. Under the Interstate and Foreign Quarantine Regulations, the Public Health Service is responsible for inspecting and certifying water supplies used by interstate and foreign public conveyances in the United States. Responsibility for certification of interstate water supplies involves sanitary engineering inspections and evaluations of approximately 780 public water supply systems serving some 92 million local populace and over 2 million interstate travelers daily. To assure compliance with the Public Health Service drinking water standards surveys are made by our personnel in company with personnel of State health departments and local water purveyors of the source, treatment processes, storage, distribution system, and supporting laboratory services.

While the drinking water standards were created to apply to water supplies used by interstate carriers they have also been generally used by State water supply sanitation agencies and by the American Water Works Association as the standards for other water supply systems.

With the enactment of the Water Quality Act of 1965 the Federal Water Pollution Control Act was amended to create within the Department of Health, Education, and Welfare the Federal Water Pollution Control Administration. Reorganization Plan No. 2 of 1966 transferred the Federal Water Pollution Control Administration from the Department of Health, Education, and Welfare to the Department of the Interior. Under the terms of the transfer, the Department of Health, Education, and Welfare retained the responsibility for advising the Department of the Interior on the public health aspects of water pollution.

An interdepartmental agreement of September 1966 between the Department of the Interior and HEW, following the transfer, defined HEW responsibilities in the following broad areas: (1) public health aspects of water pollution related to man's drinking water; (2) man's contact with water in recreation and work; (3) contamination of food sources, particularly shellfish; and (4) to the breeding of specific vectors of disease.

Mr. DADDARIO. Is that a proper definition of responsibility?

Mr. EVERTS. Yes, sir, we think so.

Mr. DADDARIO. Why do you say that?

Mr. EVERTS. We feel in the Public Health Service we have capabilities to assess the effects of pollution on man, particularly as it relates to his drinking water, and to his contact with recreation waters. We have had long experience in esturial pollution. Since 1925, we have worked in a cooperative program in the sanitation of shellfish, with both the State agencies and industries. While we frankly admit that we do not have all of the answers, we do have our program plans made to seek solutions to those problems of communicable disease and illness which may result from contaminants in water.

Mr. DADDARIO. I will go into that in greater length, but there is some question about the way we are organized and whether or not it is the most efficient way to organize and whether necessarily these things are compatible one with the other.

Mr. EVERTS. Yes, sir.

In fulfillment of the Department of Health, Education, and Welfare responsibility for implementing this agreement between the two agencies, the Public Health Service, where requested to do so, has reviewed and commented on those State water quality standards as related to pollution control, as submitted to the Department of the Interior before June 30, 1967. Such water quality standards proposals from 36 States have been reviewed by PHS field offices and comments have been made on the adequacy of those standards to protect drinking water supplies as well as waters to be used for water contact sports or shellfish production. Twelve States are now under review and two have not yet been received.

The Public Health Service has under preparation health guidelines for water quality as related to pollution control, in the following areas: Water to be used for domestic purposes and food processing; recreation use; estuarial waters and vector control. These guidelines are under intensive review by the Public Health Service and will be furnished to the Department of the Interior as soon as they are finally approved.

While the public health drinking water standards and the proposed new health guidelines represent the best current knowledge in protecting the water and shellfish consumers from communicable diseases or illness, we know that health aspects associated with pollution of water in relation to the various users are numerous, complex, and certainly to date have not been adequately studied. Technological process continually creates new contaminants that must be evaluated. Restrictive limits for many of the new materials or for the existing low-level contaminants found in drinking water supplies are, however, difficult to establish because of the gap in knowledge regarding acute and chronic physiological effects on humans. In some cases, the analytical procedures and treatment technology need improvement.

Of equal concern is the need to determine whether or not the barriers guiding against biological contamination of drinking water supplies are being strained to the breaking point. To what degree time-tested supply safeguards and safety factors have been reduced to dangerous levels poses a vital question. Little is actually known of quantitative procedures for isolating pathogens from water, and from the infectious dose of many pathogens that reach our water intakes. Current extensive experimentation with, and the eventual need for, waste water reuse with resultant increase of biological hazards as well as buildup of chemical contaminants, imposes on the Public Health Service an inescapable responsibility for determining the health hazard potential. The Service is equally responsible for assuring that meaningful indicator indices are developed and used in assessing the impact of water renovation on human health. The urgent need for such research has been supported both by rhw Committee on Water Resources Research of the Federal Council for Science and Technology and the Federal Water Pollution Control Administration.

Our future program will involve additional research and development resources pertaining to water quality on health, including refinement of meaningful potable water standards. Investigations will include: (1) Development for improved methods for the identification and measurement of organic materials and trace elements occurring in drinking water supplies; (2) epidemiological and toxological studies to determine the significance of organic material and trace elements in relation to human health; (3) development of suitable methods for the removal of harmful trace contaminants, determination of human health effects of water that has been renovated from polluted sources; and (4) initiation of development of rapid determinable tests to assure public drinking water supplies of good quality.

Mr. DADDARIO. Now, shouldn't that be the responsibility of the Federal Water Pollution Control Administration? If it is not, and you should do it, should they be doing it, too? How do you coordinate your activities?

Mr. EVERTS. Under the terms of the interdepartmental agreement, we have been assigned these responsibilities. The Public Health Service has a long history of dealing with matters relating to human health, and we have the resources to do it.

Mr. DADDARIO. I do not disagree with that. It is just that since the Federal Water Pollution Control Administration does have certain responsibilities, we are concerned with how the governmental agencies are set up and who is doing what and why, especially regarding No. 3, the development of suitable methods for the removal of harmful trace contaminants, et cetera. That certainly is an FWPCA responsibility. It becomes a question of how much are they doing and how much are you doing. Ought it to be done by both of you? How do you coordinate it?

Mr. EVERTS. Yes, sir. May I comment on that?

It seems to me that we have to get a little clearer definition of the treatment of waste water and the treatment of water to be used for drinking purposes. These are two separate and distinct processes.

Mr. DADDARIO. We recognize that they are distinct; they are separate. Yet, in the final analysis, someone has to put it all together and explain why, even though it may be for different purposes and it may be done in separate places.

Mr. EVERTS. We are really dealing in different quality standards. We have established our standards on the basis of those elements that should have limiting factors in relation to the use of water for drinking purposes.

Mr. DADDARIO. That is really not what I am talking about, although it is part of it. We are trying to get to the way it is being managed.

I have here a chart of proposed water resources research expenditures for fiscal 1968. Under "Water treatment" you have both Interior and HEW spending a considerable amount of money.

How have you established this relationship so that everybody knows what everybody else is doing? Since we are talking about water treatment ought it to be put under one head?

Mr. EVERTS. I do not have before me the figures which you have there, but our expenditures in direct operations research for the fiscal years 1967 in the water supply research program have only been about $328,000.

Mr. DADDARIO. Mr. Carpenter will show you the line items.

Mr. EVERTS. In 1968 our research—and this may be a misnomer when we are talking about water treatment—our expenditures authorized for the 1968 fiscal year are $520,000. For the 1969 fiscal year there is an anticipated increase of some $750,000 in research activities in the water supply program.

Mr. DADDARIO. Is that figure correct for Interior, Dr. Weinberger?

Dr. WEINBERGER. Mr. Chairman, it represents the total departmental budget. I would suspect that certainly it is very close to being correct, subject to some changes that might have been made in the 1968 estimate. It does represent a 1968 estimate but the change would not be very large from these figures.

Mr. EVERTS. A substantial part of that money will be used in disease studies, studies of chronic illness, which may be of water origin. In answer to your other question about departmental program relationships, under the interdepartmental agreement the Department of the Interior and the Department of Health, Education, and Welfare each have a liaison representative who meet to coordinate activities between the two agencies to be sure that there would be no overlap, or to reduce duplication as much as possible between the two agencies. They are Mr. Allan Hirsch from the Department of the Interior and Mr. Vernon MacKenzie from the Department of HEW.

Mr. DADDARIO. A lot of sins in management have been covered up by the idea that we establish a liaison. I ask the question because this area is expanding, and because there are so many complications and questions about criteria. There are different standards we must apply for different purposes. Before we develop a confidence in our ability to deal with these problems, we have to make certain that our management efforts, the way we coordinate our activities, are much better than they are. This is not your direct responsibility, and perhaps I should not even be making the observation, but it is not my feeling that we do a good job simply by pointing to the fact that liaison people have been created. It often covers up more than it improves.

Mr. EVERTS. Knowing both of these gentlemen and having worked with both of them in times past, I am sure this will be a very effective liaison arrangement. I would also like to add to my earlier comments that it has been my experience over the years that in order to develop public confidence that where the health agency has had the responsibility for the development of criteria and the standards, particularly where human health is involved, that they have discharged this responsibility in admirable fashion. They are well equipped through their resources in research, medicine, and in engineering, to handle their part of the problem in good fashion.

Mr. DADDARIO. I find nothing in what you say to be in conflict with what I have been saying. The fact is you are pointing to the capability of your Department to do this. Yet, the Federal Water Pollution Control Administration is going to have the responsibility, and they are the ones upon whom we have to have the confidence. We have to know then how your competence can be translated to them. In the proliferation, you run into some difficulties.

Mr. EVERTS. I think we have to work very closely with them in an advisory capacity. However, I see no obstacles to consummating such an arrangement.

Mr. DADDARIO. If you will continue, please.

Mr. EVERTS. As part of the public health aspects of pollution in estuaries, the shellfish sanitation research program of the Public Health Service will continue providing scientific data required for maintenance of effective controls to prevent transmission of disease agents through marine foods, notably shellfish. Emphasis will parallel problems associated with natural and manmade contaminants, both chemical and microbiological, of estuaries. Attention will be given to controlled laboratory studies on the uptake, retention, and elimination of potentially toxic agents in order to establish or validate safe limits for estuarial water and shellfish. Laboratory, pilot plant, and field studies will be directed toward survival of human disease-causing viruses in estuaries and their uptake, retention and depuration by shellfish; development of accurate laboratory methods for assay of industrial wastes, naturally occurring marine toxins, pesticides, viruses, bacteria, and other similar disease-causing microorganisms in shellfish; ecology, biogenesis and detoxification of marine toxins; and refinement of methods for the depuration and/or detoxification of shellfish.

In recognition of the expanding demands for water throughout the Nation, Congress established through the 1965 Water Resources Planning Act a national policy for conservation, utilization and development of water and related land resources. As one of the five principal members of the Water Resources Council established under the act the

Secretary of Health, Education, and Welfare is also represented by Public Health Service staff members on the various river basin commissions, interagency planning groups and field committees.

HEW responsibilities in water resources planning include:

A. Assessment of the potential of disease outbreaks and the means for their prevention and control.

B. Assessment of the availability, protection, and safety of community water supplies.

C. Assessment of the health significance of specific contaminants with regard to:

1. Recreational water use.
2. Community water supplies.
3. Shellfish or marine food production.

D. Assessment of other conditions of health significance affected by water resource development:

1. Vector-borne disease hazards.
2. Air pollution.
3. Solid wastes disposal operations.
4. Planning and environmental control for recreational developments.
5. Radiological health.

The Public Health Service has provided initial implementation of its responsibilities in the area of water resources planning. Some review and consultation have been offered to Federal and State agencies on the health aspects of water resources projects. Public health consultation has been provided to five national technical committees on water quality criteria, and comments have been developed on public health aspects for two water resources planning projects. We hope to strengthen technical staff in our regional offices for project reviews and other program functions to insure adequate consideration of public health aspects of water resources planning. The development of public health guidelines for the use of water pollution control and water resources development agencies is urgently needed as well as the development of public health comments in the form of comprehensive health aspects appendixes for inclusion in the reports of the national planning studies: and the development of technical assistance capabilities utilizing research and surveillance data on water pollution and disease.

If there are any further questions, Mr. Chairman, I will be glad to try to answer them or to furnish additional material for the committee.

Mr. DADDARIO. Mr. Everts, we will have more questions for you for the record. The few that I would ask now would not necessarily improve those, so I will leave them to be submitted to you in written form.

I just have an observation, Dr. Weinberger: Last year when we were having our pollution hearings we were asking where we were and what was going on. The day after our hearing Secretary Udall announced a breakthrough in phosphate removal from municipal sewage. We were somewhat surprised that that breakthrough was developed immediately after our hearings had ended. We would hope that if you do have a breakthrough tomorrow that you will tell us today.

Dr. WEINBERGER. Mr. Chairman, I am going to Chicago this evening and I will be appearing there. I hope it will not be characterized as a breakthrough, that is, my presentation there tomorrow. It will be a factual reporting of where we stand in terms of removal of one impurity.

Mr. DADDARIO. It is little things like that, Mr. Everts, that sometimes show the gaps that exist in our liaison capabilities.

QUESTIONS SUBMITTED TO CURTISS M. EVERTS BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

Question 1. Does the Public Health Service or the Federal Water Pollution Control Administration feel that adequate information on human health criteria is available to allow total reuse of municipal waste water? If not, what is missing, who is responsible for getting the facts, and when will we know whether this alternative water supply is available?

Answer. It is believed that we have only enough information at the present time to proceed with pilot plant tests of processes for the use of reclaimed waste waters for all purposes. Processes now exist for renovating waste waters for use as water supplies, but the questions that have not been answered involve economics, the reliability of these processes, and the development of suitable standards by which their performance may be evaluated.

Although standards applicable to public drinking water supplies have been in use for more than 50 years, little, if any, work has been done to establish a basis for the development of criteria that could be applied to the use of reclaimed municipal waste water for all purposes. Drinking water standards always have included provisions for sanitary surveys of the water source to ensure that the water treatment plant used a raw water that was relatively unpolluted. Morbidity and mortality data have supported these finished water standards, for acute health effects in humans have not been attributed to waters that have met the standards. All possible toxic elements and compounds that could occur in water are not included in the standards for the reason that they have not been present in amounts considered significant, or they may have appeared only in trace concentrations on an erratic or periodic basis. If the raw water souurce is sewage, where contaminants are present in more concentrated form, a much more extensive set of standards will be necessary.

During the past decade, much has been learned about treatment of waste water for removal of some organic substances and bacteria. Not enough effort, however, has been devoted to the development of methods to remove other harmful contaminants, such as trace elements, pesticides, and some unidentified viruses.

Since little, if any, control can be exercised over the disposal of chemicals and other harmful substances into waste water collection systems, the problem of establishing fail-safe operating and control criteria for reuse of waste water becomes quite a complex problem, particularly when the reclaimed water is to be used for drinking and culinary purposes.

Whether reclaimed waste water can be used for all purposes also will depend upon the development of reliable methods and techniques for waste water treatment and for identification of contaminants. In addition, meaningful indicators must be developed and used to assess the impact of renovated waste water on human health. For example, such elements as copper, at the optimum level, are beneficial, but, at concentrations higher than optimum, they may prove harmful.

Except in a research situation, a water renovation plant could not be expected to analyze for everything that could be discharged into a sewer. Analytical cost and time would make the system impracticable. Some screening or indicator test procedures must be developed.

More precisely, the new information and techniques required are:

1. Improved and more rapid methods for the identification and measurement of pathogenic bacteria, viruses, and indicator organisms.
2. Improved techniques for the identification and measurement of trace elements and of natural and synthetic organic materials.
3. The determination of human health effects related to consumption of waters containing substances found in reclaimed waste waters.
4. The development of waste water treatment systems that can be depended upon to continuously operate and produce a water of safe quality for domestic use at all times.
5. Determination of the effectiveness of present advanced water treatment facilities in removing pathogenic parasites and other contaminants from waste water.

6. The development of monitoring equipment capable of operating fail-safe devices if purification equipment fails to operate or treatment facilities fail to produce a water of satisfactory quality.

The Public Health Service, on the basis of its long experience in matters related to human health and water supply, is the agency best equipped to undertake the investigations in the first three studies outlined. State health agencies that are charged with local water supply responsibility have traditionally looked to the Public Health Service to provide the leadership and guidance in matters related to the protection and purification of public water supplies. The Water Supply and Sea Resources Program of the National Center for Urban and Industrial Health and the Division of Environmental Health Sciences of the National Institutes of Health would require from 3 to 4 years, after adequate funds are made available, to complete the work necessary to establish initial criteria.

The Federal Water Pollution Control Administration, on the basis of its work and experience in advanced waste water treatment systems and in the development of monitoring equipment, is best qualified to undertake the investigations in the next two areas outlined. The Administration is best qualified to indicate the time required to develop the equipment and devices outlined.

The development of suitable monitoring equipment seems to be an area where there will be some overlapping of research interest. Research undoubtedly will be undertaken by the Federal Water Pollution Control Administration to develop devices to ensure the continuous operation of waste treatment plants so that poor operation or bypassing will not endanger aquatic life in receiving waters. We also must upgrade the operation of water treatment plants to ensure that disease outbreaks do not continue to occur. Equipment design for both of these purposes would be usable for waste water renovation plants. The research might differ as to the degree of precision required or as to the parameters measured. It is anticipated that the liaison developed under the interdepartmental agreement would ensure that research is not duplicated, but that each study complements other research.

The use of reclaimed waste water for drinking purposes should be planned only if no other suitable fresh water source is available. It should be pointed out that waste water for purposes other than drinking and culinary use could be reclaimed more quickly, particularly where separate systems for irrigation, fire protection, cooling water, and street flushing are appropriate.

Since drinking water is only a small portion of our total water need, possibly it can be provided more economically if it is separated from the total supply and delivered to the consumer in a special distribution system. When more is known about cost of water renovation and the cost of monitoring the operation, an economic analysis of alternative methods of supply may indicate the best solution. There also will be an interest, however, in treating the water only to the degree necessary. Standards can not be overly conservative and must be justified. But, on the other hand, surveillance for health protection must be included, as there always will be the urge to economize too much.

Question 2. The health effects of nitrates in air, food and water have been considered recently. What do we know about the sources, persistence, mobility and effects of nitrate nitrogen? What would abatement entail? What priority should this contaminant receive? Since nitrate nitrogen moves in both air and water, which Federal agency is responsible for obtaining the facts?

Answer. We do not feel that nitrate problem is interrelated with all aspects of environmental pollution. The problem is to determine the contribution, if any, from each source. We have checked with epidemiologists of the National Center for Air Pollution, and their similar-sounding problem is one of oxides of nitrogen produced during combustion. These gases, nitrogen dioxide and nitrogen tetroxide, in high concentrations are toxic to humans; the effects of trace concentrations are under investigation. High concentrations of these gases in air overlying water would result in some nitrates and nitrites being absorbed by the water. Trace concentrations, however, that are involved with air pollution would result in an insignificant uptake by water.

A 1966 Monograph by the National Academy of Sciences—National Research Council, *Toxicants Occurring Naturally in Foods*, reviews the nitrates and nitrites problem. Addition of these chemicals to a limited number of meat and fish products is permitted. Their use must continue to be controlled, however, inasmuch as poisonings from misuse have occurred.

Problems with cattle feeds containing nitrates have also been reported. Adult humans are not affected by nitrates occurring in vegetables, but reportedly they have caused illness in infants.

Methemoglobinemia has occurred in infants given water or formula made from water with a nitrate concentration greater than 45 ppm as nitrate. The Drinking Water Standards use this concentration as a recommended limit. These cases of methemoglobinemia have apparently been adequately explained by the nitrate concentration of the water, and the further complication of food intake has not been involved. The unresolved problem is why methemoglobinemia does not always occur from use of water high in nitrate. As only a select segment of the population is involved (infants less than 6 months), and then not always, there is agitation to raise the allowable concentration. Bottled or other water could be supplied for the bottle-fed infants. Cow's or mother's milk is reputed not to contain nitrates. In the foreign literature, studies of subclinical effects in older children have been reported, and we plan to conduct similar investigations.

Nitrate from natural causes is a problem in some groundwater, and the problem is increased where polluted water is used to recharge groundwater. Nitrate is a difficult contaminant to remove from waste water. It is possible that the nitrate concentration will be the controlling factor in some applications of waste water reuse. Any recommended limits in the Drinking Water Standards must, therefore, be justified on the basis of sound research because of the far reaching economic consequences of meeting this standard. In some cases, the most economical solution may be to supply special water to families with infants, unless research shows that a large portion of the population is effected.

Although the presence of nitrate in drinking water presents a problem, so many other contaminants, such as lead and arsenic, have a much more pronounced effect on human health that we lack sufficient knowledge of relative toxicities to establish a priority at this time.

Question 3. Dr. Bernard B. Berger, Director of the Water Resources Research Center at the University of Massachusetts, has recently stated "While we must admit that health statistics do not support a claim that the polluted urban environment constitutes a clear and present public hazard, it must be emphasized that we have not looked hard and long enough to be absolutely certain of this claim." Do you agree with both parts of this statement?

He goes on to say: "The epidemiologist is not attracted by a challenge of this kind. He prefers to work with overt disease outbreaks." What is the portent of this statement for bringing greater confidence to decisions in pollution control that will be costly and disruptive to industry and to our mode of living?

Answer. We agreed with both parts of Dr. Berger's statement. Health statistics are developed on the basis of the number of cases of deaths from reportable communicable disease in a community, as well as the number of deaths resulting from chronic diseases, accidents, and natural causes.

Geographic differences in mortality have long been noted. Infant mortality has been noted. Infant mortality has been a sensitive measure of sanitation, and rural death rates for a long time were higher than urban rates. A shift has occurred, however, that may be attributed to a deterioration of the quality of the urban environment as well as to improvements in rural living. The rural-urban differences are also noted for other disease death rates. The higher mortality in the central cities, as compared with the noncentral city counties, has been attributed to air pollution. Many causes of death are correlated with the population size of the metropolitan environment.

Some environmental contaminants may have such subtle long-term effects on human health that they would not be noticed as readily as the explosive epidemic of a communicable disease or the acute toxic effects of a poison.

Seldom is mild gastroenteritis or "stomach flu" from a water or food supply severe enough to require medical care; generally it goes unreported. The identification of many organic materials in drinking water has not been accomplished, and the correlation with any health effects of those that have been identified has been undertaken in only a modest and cursory fashion.

Morbidity may prove to be more sensitive to environmental differences, but the illness data necessary to make very detailed geographic comparisons are not available. Current sampling procedures only allow comparison of larger areas, such as regions of the country or, at best, the largest metropolitan areas. On a few occasions, special epidemiological studies have been conducted to evaluate the effect of the environment on morbidity. But these studies are costly.

Besides the problem of obtaining data on health parameters, data on environmental conditions are needed to relate to these health data. To what level of contamination is the public exposed? We do not have water quality data on the drinking water actually consumed by the public. The data we have are on the quality of water leaving the unpolluted source or the treatment plant. This is changed by contact with the distribution system and with household plumbing.

Many epidemiologists trained in communicable disease control are not attracted by the challenge of studying the effects on human health resulting from more subtle materials. Such tedious and time-consuming work requires that a number of different scientific disciplines be brought together in a planned stack on such "environmental contaminant-disease" related problems.

Disease outbreak investigation is, of course, a classical role for the epidemiologist. In this situation, many cases are compared for common exposure, and the cause is determined. Another investigative technique, the retrospective study, compares the past experience of a group of ill persons with a control group of well persons to investigate chronic disease causes. Probably the chronic diseases do not have a single sufficient cause, but many conditions influence their cause. The retrospective study, which finds the most dominant cause first, would not be able to determine the more subtle effects of, say, water quality until the more dominant causes were controlled. This might be illustrated with the example of cancer of the lung; it is difficult to show the effect of air pollution when the most dominant cause is cigarette smoking.

Prospective studies are used by epidemiologists, but they are costly. Here, one with population, and another without, the environmental contaminant are followed to see how many cases of disease develop. The study populations must be large and can differ in only a few environmental conditions.

Although the Public Health Service Drinking Water Standards represent the best current knowledge on the protection of water and shellfish consumers from communicable disease and illness, the health aspects associated with the pollution of water are numerous and complex and certainly have not been adequately studied. As we have pointed out before, technological progress constantly creates new contaminants that must be evaluated in relation to their effect in human health.

Frankly, we do not know enough about the acute and chronic effects on human health of some contaminants found in water, and until we do, the development of meaningful standards will be delayed. The best that can be done at present is to use current knowledge until adequate funding becomes available for the required research, studies, and investigations that will provide answers to these problems.

In those instances where there appears to be a relationship between environmental contaminants such as organics or trace elements in water supplies and chronic disease, the Public Health Service has now organized its resources both at the National Center for Urban and Industrial Health in Cincinnati and at the Division of Environmental Health Sciences of the National Institutes of Health in North Carolina to undertake careful and precise studies, investigations, and assessments of these relationships in an effort to unearth some of the facts on which future water quality criteria can be developed.

We do not believe that calculated risks can be assumed where human health is involved; where harmful contaminants are present in drinking water supplies, they must be removed.

PREPARED STATEMENT OF CURTISS M. EVERTS, CHIEF, WATER SUPPLY AND SEA RESOURCES PROGRAM, NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH, PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, CINCINNATI, OHIO

The interest of the Public Health Service in problems of water supply and its relations to health began in 1912 with the enactment of Public Law 410. These statutes authorized the Surgeon General to conduct research investigations and studies related to the cause, and prevention of diseases and impairments of man; to make and enforce certain public health regulations including those relating to the prevention of the interstate spread of communicable diseases; and accept assistance from and to assist States in obtaining compliance with regulations, as well as to control and prevent disease.

The Interstate Quarantine Regulations and the Public Health Service Drinking Water Standards wore promulgated pursuant to such authorization. Under the Interstate and Foreign Quarantine Regulations, the Public Health Service is responsible for inspecting and certifying water supplies used by interstate and foreign public conveyances in the United States. Responsibility for certification of interstate water supplies involves sanitary engineering inspections and evaluations of approximately 780 public water supply systems serving some 92,000,000 local populace and over 2,000,000 interstate travelers daily. To assure compliance with the Public Health Service Drinking Water Standards surveys are made by our personnel in company with personnel of State health departments and local water purveyors of the source, treatment processes, storage, distribution system, and supporting laboratory services.

While the Drinking Water Standards were created to apply to water supplies used by interstate carriers they have also been generally used by State water supply sanitation agencies and by the American Water Works Association as the standards for other water supply systems.

With the enactment of the Water Quality Act of 1965 the Federal Water Pollution Control Act was amended to create within the Department of Health, Education, and Welfare the Federal Water Pollution Control Administration. Reorganization Plan No. 2 of 1966 transferred the Federal Water Pollution Control Administration from the Department of Health, Education, and Welfare to the Department of the Interior. Under the terms of the transfer, the Department of Health, Education, and Welfare retained the responsibility for advising the Department of the Interior on the public health aspects of water pollution.

An interdepartment agreement of September 1966 between the Department of the Interior and HEW, following the transfer, defined HEW responsibilities in the following broad areas: 1) public health aspects of water pollution related to man's drinking water; 2) man's contact with water in recreation and work; 3) contamination of food sources, particularly shellfish; and 4) to the breeding of specific vectors of disease.

In fulfillment of the Department of Health, Education, and Welfare responsibility for implementing this agreement between the two agencies, the Public Health Service where requested to do so has reviewed and commented on those State water quality standards as related to pollution control, submitted to the Department of the Interior before June 30, 1967. Such water quality standards proposals from 36 States have been reviewed by PHS field offices and comments have been made on the adequacy of these standards to protect drinking water supplies as well as waters to be used for water contact sports or shellfish production. Twelve States are now under review and two have not yet been received.

The Public Health Service has under preparation Health Guidelines for Water Quality as related to pollution control, in the following areas: Water to be used for Domestic Purposes and Food Processing; Recreation Use; Estuarial Waters and Vector Control. These guidelines are under intensive review by the Public Health Service and will be furnished to the Department of the Interior as soon as they are finally approved.

While the Public Health Service Drinking Water Standards and the proposed new Health Guidelines represent the best current knowledge in protecting the water and shellfish consumers from communicable disease or illness, we know that health aspects associated with pollution of water in relation to the various users are numerous, complex, and certainly to date have not been adequately studied. Technological progress continually creates new contaminants that must be evaluated. Restrictive limits for many of the new materials or for the existing low-level chemical contaminants found in drinking water supplies are, however, difficult to establish because of the gap in knowledge regarding acute and chronic physiological effects on humans. In some cases the analytical procedures and treatment technology need improvement.

Of equal concern is the need to determine whether or not the barriers guarding against biological contamination of drinking water supplies are being strained to the breaking point. To what degree time-tested supply safeguards and safety factors have been reduced to dangerous levels poses a vital question. Little is actually known of quantitative procedures for isolating pathogens from water, and of the infectious dose of many pathogens that reach our water intakes. Current extensive experimentation with, and the eventual need for, waste water re-use with resultant increase of biological hazards as well as build-up of chemical contaminants, imposes on the Public Health Service an inescapable responsibility for determining the health hazard potential. The Service is equally responsible for assuring that meaningful indicator indices are developed and used in assessing the impact of water renovation on human health. The urgent need for such research has been supported both by the Committee on Water Resources Research of the Federal Council for Science and Technology and the Federal Water Pollution Control Administration.

Our future program will involve additional research and development resources pertaining to water quality on health, including refinement of meaningful potable water standards. Investigations will include: 1) development of improved methods for the identification and measurement of organic materials and trace elements occurring in drinking water supplies; 2) epidemiological and toxicological studies to determine the significance of organic material and trace elements in relation to human health; 3) development of suitable methods for the removal of harmful trace contaminants, determination of human health effects of water that has been renovated from polluted sources; and 4) initiation of development of rapid determinable tests to assure public drinking water supplies of good quality.

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A. Assessment of the potential of disease outbreaks and the means for their prevention and control.

B. Assessment of the availability, protection and safety of community water supplies.

C. Assessment of the health significance of specific contaminants with regard to:

1. Recreational water use
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D. Assesssment of other conditions of health significance affected by water resource development:

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Mr. DADDARIO. This committee will adjourn until tomorrow morning at this same place at 10 o'clock.

(Whereupon, at 12:42 p.m., the subcommittee recessed, to reconvene at 10 a.m., Thursday, February 1, 1968.)

ENVIRONMENTAL QUALITY

THURSDAY, FEBRUARY 1, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10:20 a.m., in room 2325, Rayburn House Office Building, Washington, D.C., Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. The subcommittee will come to order.

My apologies to you all for holding up the meeting, but my plane, which was supposed to have arrived an hour ago, just got here. It is important for us to get back to our home district, even in the middle of the week.

Dr. Tape. I understand.

Mr. Daddario. This subcommittee has followed the development of civilian nuclear electric power reactors with considerable interest. The Joint Committee on Atomic Energy and the Atomic Energy Commission are to be highly commended for the ambitious but thorough planning strategy which is apparent in the program.

Our study of environmental quality suggests that nuclear electric power could contribute significantly to pollution abatement. Not only would powerplant emissions be reduced compared to fossil-fuel combustion, but cheap power may lead to electrical space heating, thus eliminating small, hard-to-control combustion equipment.

But atomic energy labors under a number of doubts and constraints, some real and some based on emotion, whereas most water and air pollutants discussed in these hearings produce health effects only after substantial exposure. The release of virtually end radioactive materials into the environment is to be avoided. The reliability of nuclear waste management is thus a prime consideration, and the forecast of the growth of nuclear power means that we need confidence now that future wastes can be controlled.

If the research and development of long-term reactor waste management techniques can be shown to be proceeding at a proper pace, then atomic energy can take a major role in restoring and maintaining the quality of the environment.

Our witnesses today include Commissioner Gerald F. Tape, who is accompanied by Dr. Joseph A. Lieberman, Assistant Director for Nuclear Safety, Division of Reactor Development and Technology, AEC.

We are pleased to have both of you here. Since time is already short, we should proceed immediately.

(The biographies of Dr. Tape and Dr. Lieberman follow:)

DR. GERALD FREDERICK TAPE

Dr. Gerald F. Tape was born in Ann Arbor, Michigan, on May 29, 1915. After receiving his A.B. degree at Eastern Michigan University in 1935, he entered the University of Michigan, where he received his M.S. degree in physics in 1936 and his Ph. D. in 1940.

In 1939, Dr. Tape was appointed instructor in physics at Cornell University, where he was associated with the cyclotron research group, and used cloud chamber techniques for the study of neutron interactions with hydrogen and deuterium. He joined the staff of the Radiation Laboratory, Massachusetts Institute of Technology, in 1942 to work on World War II projects that included the development of airborne radar and radar relay equipment. He also helped to develop equipment for training radar operators under simulated conditions. During 1944 and 1945, he directed the aribone radar work of the MIT Radiation Laboratory in Europe, operating primarily with the U.S. Eighth Air Force from laboratory headquarters in Malvern, England. In 1946, he became a member of the University of Illinois staff, serving first as assistant professor and later as associate professor of physics. He was in charge of the administration and teaching of engineering physics courses and also continued his work in nuclear physics and cyclotron development.

Dr. Tape became associated with Brookhaven National Laboratory, Upton, Long Island, N.Y., on July 1, 1950. He served as Deputy Director from October 1951 to May 1962, during which time he was involved in all scientific, technical and administrative aspects of the laboratory's program. On January 18, 1962, he was appointed Vice President and on October 19, 1962, President of Associated Universities, Inc., the corporation which operates the Brookhaven National Laboratory for the Atomic Energy Commission and the National Radio Astronomy Observatory for the National Science Foundation.

Dr. Tape was nominated by President Kennedy on April 3, 1963, to fill the unexpired term of Dr. Leland J. Haworth, who was appointed Director of the National Science Foundation. He took office on July 15, 1963, and his term expired on June 30, 1966. Dr. Tape was reappointed by President Johnson for a term expiring on June 30, 1971.

His chief scientific interests are nuclear physics, accelerator development, research reactors, radar development and radio astronomy. He is a Fellow of the American Physical Society and a member of the American Nuclear Society, American Astronomical Society and the American Association for Advancement of Science. He received an honorary doctor of science degree from Eastern Michigan University in June 1964.

Dr. Tape received an Army-Navy Certificate of Appreciation in 1947. He is a member of Phi Beta Kappa, Sigma Xi, Phi Kappa Phi and Kappa Delta Pi.

Dr. Tape and his wife, the former Josephine Waffen, live at 7705 Winterberry Place, Bethesda, Maryland. They have three sons, Walter Richard, James William and Thomas Gerald.

DR. JOSEPH A. LIEBERMAN

Dr. Lieberman attended The Johns Hopkins University where he received the Bachelor of Engineering degree in 1938 and the Doctor of Engineering degree in 1941. Following military service with the Corps of Engineers in the Pacific Area in World War II, he was engaged in hydrologic research with the U.S. Forest Service. In January 1949, he joined the Atomic Energy Commission as a Sanitary Engineer in the Division of Engineering. In December 1956, he became Chief of the Environmental & Sanitary Engineering Branch, Division of Reactor Development. He was appointed to his present position of Assistant Director for Nuclear Safety, Division of Reactor Development and Technology in August 1961. He was Secretary of the Subcommittee on Waste Disposal and Dispersal of the National Academy of Sciences, member of the Interim Committee on Nuclear Wastes of the Federation of Sewage nad Industrial Wastes Association, Chairman of the Waste Disposal Subcommittee of the American Standards Association, and is a member of the Subcommittee on Radioactive Waste Disposal by Incineration of the National Committee on Radiation Protection, the AEC member of the Federal Council for Science and Technology Committee on Water Resources Research, member of the Environmental Engineering Intersociety Board, Inc., Committee on Engineering Education. He is also a Diplomate of the American Academy of Sanitary Engineers, a Registered Professional Engineer, and a member of the Society of Sigma Xi. He was a Technical Delegate to the 1958 and 1964 Conferences on Peaceful Uses of Atomic Energy in Geneva and has participated in technical exchanges with the U.S.S.R., Australia, Japan and Latin America.

STATEMENT OF DR. GERALD F. TAPE, COMMISSIONER, ATOMIC ENERGY COMMISSION, AND DR. JOSEPH A. LIEBERMAN, ASSISTANT DIRECTOR FOR NUCLEAR SAFETY, DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY, ATOMIC ENERGY COMMISSION

Dr. TAPE. Thank you, Mr. Chairman.

The principal testimony this morning will be given by Dr. Lieberman. He has a statement which he has prepared for you. However, I would like to say just a few things before Dr. Lieberman proceeds with his statement.

I think it important to recall that when we are talking about the presence of radioactive materials and radiation as a potential environmental contaminant, we are talking about something that we cannot see, don't feel, don't smell. Many of the things we think about in terms of contaminants can be detected with the normal senses. You realize there is something not quite right.

So, in the field of atomic energy, which deals with radiation and radioactive materials, it has been necessary from the very beginning to be alert to this difference between other materials and radioactive materials. Therefore, we have had to develop a research and development program, and an operational program, which look toward instrumentation and toward developing knowledge of the situation. Advanced analysis is used to be able to predict what may or may not happen, and then operational procedures and practices which would take all of these into account are established.

So I think it quite interesting that from the very beginning of the functioning of our agency we have had to recognize and have recognized the potential impact of this particular type of potential contaminant.

Recognition of the nature of these potential problems has very logically resulted in the development and application of a policy toward preventing possible adverse environmental effects, rather than trying to cure something that may have already taken place. So, the emphasis has been on prevention.

Another factor which I think is important to recognize is that we started from the beginning when there were no nuclear reactor plants. In other words, we developed them and developed the safety and the operational procedures connected with them from the beginning. So, again, where other areas may have the problem of trying to cure a situation which is already in being but is getting worse because of the magnitude of the problem, we started at a time when there was essentially no such contamination, and we have prevented such contamination from developing.

This has led us to a research, development, and operational program which has been directed toward obtaining basic information on the nature and behavior of the radioactive materials with respect to the environment. From the very beginning, our biomedical research program has had a very strong component looking at the interaction of radiation and the environment. We have had to develop the technology to provide for the proper management and handling of these radioactive materials. This has been done through AEC's own operational program which was involved first in the military program and later in setting the pattern for the civilian work. We have had to carry out operations in a manner that gives priority to safety, not only radiation safety but industrial safety as well, and I am pleased to say this works back and forth, because one becomes more safety conscious.

We have had to develop standards and criteria—for example, radiation protection guides by which these operations could be measured.

We have done this throughout the years looking to our national laboratories, looking to our contractors, and we have actually developed through this procedure a very major competence in essentially all the scientific disciplines that relate to environmental questions. It has cut across the lines of chemistry, physics, biology, geophysics, engineering, medicine, and so on.

Although this has been a record of the past, I think none of us can relax in any way or can rest on our laurels. We recognize these are continuing problems. As you will hear later, the role of nuclear energy in the civilian electric power economy is growing strongly and, therefore, one needs to be looking at the potential problems for the future.

Thus, it is necessary for us to keep on top of the problem, to anticipate new developments, to look for any areas in which we may have overlooked something in the past. I think you will find from Dr. Lieberman's discussion with you this morning that we have had a tremendous amount of experience and are continuing a very strong research and development and operations program to meet these needs.

With that, Mr. Chairman, I think it might be well if we go directly to Dr. Lieberman. We will both be here for whatever questioning you would like.

Mr. DADDARIO. Fine.

Will you proceed.

Dr. LIEBERMAN. Mr. Chairman, I am pleased to appear with Dr. Tape before your committee.

I might indicate some of our associates who are here. Walter Belter, Chief of the Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology; Dr. David Ballantine, who is in our Isotopes Development Division; and Dr. Nathaniel Barr, technical adviser to our Assistant General Manager for Research and Development. We might call on them to ampilfy or clarify certain points that might come up during the discussion.

Mr. DADDARIO. You may do so at any time you wish.

Dr. LIEBERMAN. Thank you, sir.

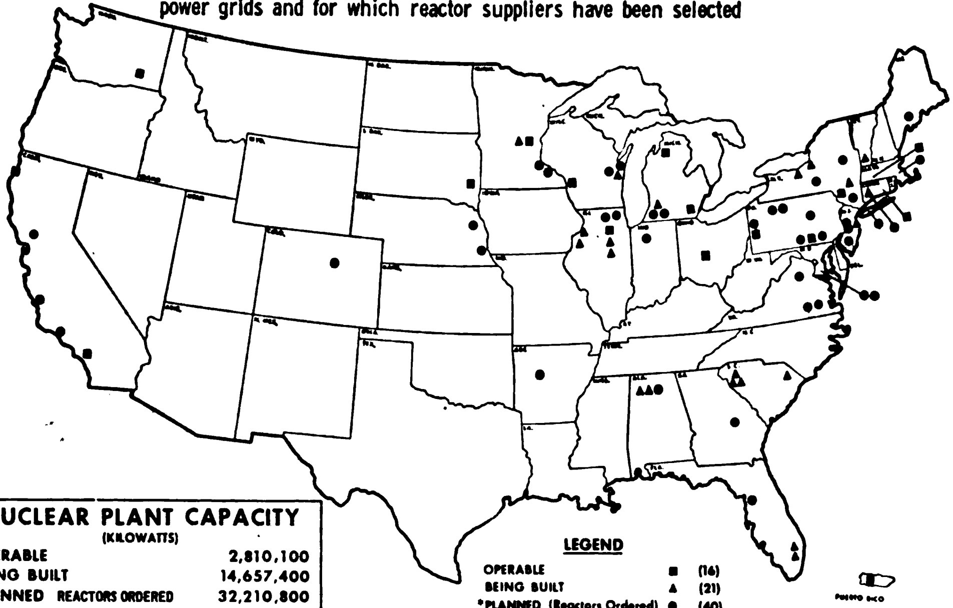
With the committee's permission, rather than reading the statement which has been prepared, which I hope can be put into the record, I would propose to try to summarize this statement rather quickly; and then, following that, I believe it might be useful to the committee to elaborate on some of the things that Dr. Tape has already indicated in the way of observations that occur to me as a result of some 19 years' association with the environmental aspects of this industry. If I have your permission to do that, Mr. Chairman, I will proceed.

Mr. DADDARIO. You may. Your full statement will be entered in the record.

Dr. LIEBERMAN. First I will point out that 1967 has marked a year of great expansion in the nuclear power industry. You have been given a map which indicates the nature of the geographic distribution of this expansion. By the end of the year 1967, there were something like 50,000 megawatts of electrical capacity committed.

NUCLEAR POWER PLANTS IN THE UNITED STATES

The nuclear power plants included in this map are ones whose power is being transmitted or is scheduled to be transmitted over utility electric power grids and for which reactor suppliers have been selected



NUCLEAR PLANT CAPACITY

(KILOWATTS)

OPERABLE		2,810,100
BEING BUILT		14,657,400
PLANNED	REACTORS ORDERED	32,210,800
	REACTORS NOT ORDERED	10,100,000
	TOTAL	59,778,300

ELECTRIC UTILITY CAPACITY BY CONVENTIONAL MEANS AS OF OCT. 30, 1967: 263,292,537 KILOWATTS

LEGEND

OPERABLE	■	(16)
BEING BUILT	▲	(21)
*PLANNED (Reactors Ordered)	●	(40)

* 12 more reactors with over 10,100,000 kilowatts have been announced for which reactors have not yet been ordered.

U.S. Atomic Energy Commission
December 31, 1967

(over)

	SITE	CAPACITY (Kilowatts)	UTILITY	STARTUP
ALABAMA	Browns Ferry	1,064,500	Tennessee Valley Authority	1970
	Browns Ferry	1,064,500	Tennessee Valley Authority	1971
	Browns Ferry	1,064,500	Tennessee Valley Authority	1972
ARKANSAS	Dardanelle Lake	825,000	Arkansas Power & Light Co.	1972
CALIFORNIA	Humboldt Bay	68,500	Pacific Gas & Electric Co.	1963
	San Clemente	430,000	Southern Calif. Edison and San Diego Gas & Electric Co.	1967
	Corral Canyon	462,000	L.A. Dept. of Water & Power	1971
	Diablo Canyon	1,060,000	Pacific Gas & Electric Co.	1971
	Sacramento County	800,000	Sacramento Municipal District	1973
COLORADO	Platteville	330,000	Public Service Co. of Colorado	1971
CONNECTICUT	Haddam Neck	462,000	Conn. Yankee Atomic Power Co.	1967
	Waterford No. 1	549,200	Northeast Utilities	1969
	Waterford No. 2	800,000	Northeast Utilities	1974
FLORIDA	Turkey Point No. 3	651,500	Florida Power & Light Co.	1970
	Turkey Point No. 4	651,500	Florida Power & Light Co.	1971
	Red Level	825,000	Florida Power Corp.	1972
GEORGIA	Baxley	800,000	Georgia Power Co.	1973
ILLINOIS	Morris No. 1	200,000	Commonwealth Edison Co.	1959
	Morris No. 2	809,000	Commonwealth Edison Co.	1968
	Morris No. 3	809,000	Commonwealth Edison Co.	1969
	Zion No. 1	1,050,000	Commonwealth Edison Co.	1972
	Zion No. 2	1,050,000	Commonwealth Edison Co.	1973
	Quad Cities No. 1	715,000	Comm. Ed. Co.–Ia.–Ill. Gas & Elec. Co.	1970
	Quad Cities No. 2	715,000	Comm. Ed. Co.–Ia.–Ill. Gas & Elec. Co.	1971
INDIANA	Burns Harbor	515,000	Northern Indiana Public Service Co.	1970's
MAINE	Wiscasset	790,000	Maine Yankee Atomic Power Co.	1972
MARYLAND	Lusby	766,000	Baltimore Gas and Electric Co.	1973
	Lusby	766,000	Baltimore Gas and Electric Co.	1974
MASSACHUSETTS	Rowe	175,000	Yankee Atomic Electric Co.	1960
	Plymouth	625,000	Boston Edison Co.	1971
MICHIGAN	Big Rock Point	70,400	Consumers Power Co.	1962
	South Haven	700,000	Consumers Power Co.	1970
	Lagoona Beach	60,900	Power Reactor Development Co.	1963
	Bridgman	1,054,000	Indiana & Michigan Electric Co.	1972
	Bridgman	1,054,000	Indiana & Michigan Electric Co.	1973
MINNESOTA	Elk River	22,000	Rural Cooperative Power Assoc.	1962
	Monticello	471,700	Northern States Power Co.	1970
	Red Wing No. 1	550,000	Northern States Power Co.	1972
	Red Wing No. 2	550,000	Northern States Power Co.	1974
NEBRASKA	Fort Calhoun	457,400	Omaha Public Power District	1971
	Brownville	778,000	Consumers Public Power District and Iowa Power and Light Co.	1972
NEW JERSEY	Toms River	515,000	Jersey Central Power & Light Co.	1968
	Keyport	800,000	Jersey Central Power & Light Co.	1973
	*	1,050,000	Delaware Valley Group	1971
	*	1,050,000	Delaware Valley Group	1973
NEW YORK	Indian Point No. 1	265,000	Consolidated Edison Co.	1962
	Indian Point No. 2	873,000	Consolidated Edison Co.	1969
	Indian Point No. 3	965,300	Consolidated Edison Co.	1971
	Scriba	500,000	Niagara Mohawk Power Co.	1968
	Easton	765,800	Niagara Mohawk Power Co.	1971
	Rochester	420,000	Rochester Gas & Electric Co.	1969
	Shoreham	540,000	Long Island Lighting Co.	1973
	Lansing	829,200	New York State Electric & Gas Co.	1973
OHIO	Piqua	11,400	City of Piqua	1963
PENNSYLVANIA	Peach Bottom No. 1	40,000	Philadelphia Electric Co.	1966
	Peach Bottom No. 2	1,065,000	Delaware Valley Group	1971
	Peach Bottom No. 3	1,065,000	Philadelphia Electric Co.	1973
	*	1,065,000	Philadelphia Electric Co.	1975
	*	1,065,000	Philadelphia Electric Co.	1977
	Shippingport No. 1	90,000	Duquesne Light Co.	1957
	Shippingport No. 2	800,000	Duquesne Light Co.–Ohio Edison Co.	1973
	Three Mile Island	831,000	Metropolitan Edison Co.	1971
PUERTO RICO	Punta Higuera	16,500	Puerto Rico Water Resources Authority	1964
SOUTH CAROLINA	Hartsville	663,000	Carolina Power & Light Co.	1970
	Lake Keowee No. 1	839,000	Duke Power Co.	1971
	Lake Keowee No. 2	839,000	Duke Power Co.	1972
	Lake Keowee No. 3	839,000	Duke Power Co.	1973
SOUTH DAKOTA	Sioux Falls	58,500	Northern States Power Co.	1964
VERMONT	Vernon	513,900	Vermont Yankee Nuclear Power Corp.–Green Mt. Power Corp.	1970
VIRGINIA	Hog Island	783,000	Virginia Electric & Power Co.	1971
	Hog Island	783,000	Virginia Electric & Power Co.	1972
	*	800,000	Virginia Electric & Power Co.	1974
WASHINGTON	Richland	790,000	Washington Public Power Supply System	1966
WISCONSIN	Genoa	50,000	Dairyland Power Cooperative	1967
	Two Creeks No. 1	454,600	Wisconsin Michigan Power Co.	1970
	Two Creeks No. 2	454,600	Wisconsin Michigan Power Co.	1971
	Carlton	527,000	Wisconsin Public Service Co.	1972

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*Site not selected.

The distribution of this is of some interest. The map, which does not indicate Federal Power Commission regions, indicates that New England, the Southeastern United States, the area around the Great Lakes, and the west coast are the areas of the country in which the growth of nuclear power will be the greatest. The estimates for the years 1980, 1990, and 2000 indicate the major expansions and concentrations of nuclear power in Federal Power Commission regions, regions 1, 2, 3, and 8—1 being the New England-New York-New Jersey area; 2 being the area around the Great Lakes; 3 being the southeastern quadrant of the United States; and 8 being the west coast.

I will get, a little bit later on, into the way in which this growth of nuclear power relates to the magnitude of the nuclear waste problem.

This nuclear growth is quite remarkable when one considers that it has really been only 10 years ago that the first plant; namely, the Shippingport plant now being operated by Duquesne Light & Power in Pittsburgh, went on the line. So, there is little question that the nuclear power industry is a viable and rapidly expanding industry.

The nuclear plants have been developed to the point where they are safe and reliable. The research and development program carried out by the Atomic Energy Commission, the test program which has been associated with this, the work by the industry which is involved in producing these plants, have all provided the technology to accomplish the basis for this rapid expansion.

I might also point out that a very vital factor with respect to both safety and reliability is the essential requirement for careful, high-grade engineering and a well developed regulatory program. These are also, obviously, very major factors in assuring that these plants are operated both safely and reliably.

Economics is, obviously, a factor in the growth. I do not think the utilities would be going through the expansion they are going through now if it were not clear that these plants provided some economic incentive to them.

However, as you indicated in your remarks at the outset, Mr. Chairman, there is an increasing awareness of the cleanliness of this method of producing electric power, particularly with respect to air pollution. It has been indicated to me by utility executives in the past that this, indeed, has been a consideration in their "going nuclear."

Mr. **Mosher**. Does that involve an economic consideration, too?

Dr. **Lieberman**. Yes.

Mr. **Mosher**. In other words, what they would have to do to clear up their conventional practices would be so costly that it is an incentive to go nuclear?

Dr. **Lieberman**. Not only the cost, Mr. Congressman, but the capabilities in some cases to do this. The existing technologies for certain aspects of air pollution control, at least in these cases, led these executives to the conclusion that for a variety of reasons their decision should be to go nuclear.

Dr. **Tape**. I think, Congressman Mosher, when decisions are made by utility executives, frequently two competing elements will come in and it may be a little difficult to tip the scale one way or the other. I think in many of these instances the uncertainties related to what they may get into in handling other pollutants may tip it in favor of knowing what they are faced with on the nuclear side.

Mr. **Mosher**. Even the uncertainties of what Congress might do?

Dr. **Tape**. That is right. To be sure, it is economics; but I think it is the uncertainty of the economics more than it is actually pricing out these differences.

Mr. **Daddario**. This is, however, a choice. You talk about New England. As I understand the New England situation, as we go ahead into nuclear development for the creation of electricity, there is simultaneous growth in the use of fossil fuel development. They go side by side.

Dr. **Lieberman**. This is quite right.

Mr. **Daddario**. The increase of one is not actually at the expense of the other.

Dr. **Lieberman**. That is quite right, Mr. Chairman.

Mr. **Daddario**. Therefore, the pollution problem which presently exists is still a problem, on the one hand, and the fact that you are running along in tandem is for other reasons.

Dr. **Tape**. One of the major reasons for the rapid growth of nuclear power, I think, is that there has been rapid growth in the whole electrical power demand. So, what we are doing is entering a market at a time when the whole market is growing significantly.

Mr. **Daddario**. Yes. That is the overriding factor——

Dr. **Tape**. It is the overriding factor.

Mr. **Daddario**. Having made a determination to go nuclear only because it was a clean way.

Dr. **Lieberman**. In certain situations this has been the case. I think all the estimates indicate that in the future the use of fossil fuels for the production of electrical power also will increase. So, I think the point you make is certainly a valid one, that the electrical demand will require the utilization of essentially all the resources we have, both nuclear and fossil fuels. So, I think it an important, and I believe, necessary conclusion, to note that the advent of increasing nuclear power, while we think it can make a significant contribution to the alleviation of these problems, will not by itself completely eliminate the problem.

Mr. **Daddario**. I would say that is a very important statement. It ought to be taken into consideration with what the Commissioner has said. To meet the demand will require the use of all of our resources, and we have come to the point in a short period of time where we have looked to the nuclear production of electricity as a resource.

Dr. **Lieberman**. The safety and waste management record of commercial plants has been and continues to be excellent. I think the record will show, for example, in the area of affluent control, the quantities and concentrations of radioactive materials that have been released into the environment have been well within, that is, less than 10 percent of, established radiation protection limits.

Mr. **Daddario**. How do you establish the 10-percent limit? Are you absolutely sure of this, or is this a guess?

Dr. **Lieberman**. No. This is not a guess.

Mr. **Daddario**. Has there been the research necessary to be absolutely sure that dosages of less than 10 percent will not be harmful?

Dr. Lieberman. Let me state it this way, Mr. Chairman: The development and establishment of these radiation protection guides and limits are based on very extensive biomedical research. The establishment of these standards has included and involved groups that are outside the AEC—the National Commission on Radiation Protection, the International Commission on Radiological Protection and Measurement—and are based on the best medical evidence available.

I might also say—this is a statement which has been made by others—that there is perhaps as much or more known about the biomedical effects of radiation than almost any other potential contaminant that we are dealing with because of the extensive amount of work which has been done. So, these radiation protection guides and the maximum permissible concentrations which are utilized in regulating and controlling the industry are based on rather extensive background information and experimental work.

Having had those protection limits or guides established, the capability for measuring these concentrations of radioactive materials in the environment has very high resolution limits so that we can measure down to very low levels. The number I quoted is really the result of the detailed monitoring which has taken place in the vicinity of operating plants. So, I think we can say, and there is data to support the conclusion, that the discharge or release of radioactive materials to the environment has not come very close—the number I used was less than 10 percent—to these radiation protection limits.

Mr. Daddario. Recognizing all you say, that the experience you have accumulated and the best information you have allows you to come to this conclusion, you would not, however, stop any research in this area to come to exact determinations upon which you could then say this is what the situation in fact is. We have not, as yet, reached that point.

Dr. Lieberman. No, sir. I think there are still questions to be answered with respect to whether there is a triggering mechanism or whether there is a threshold below which there is no effect or whether really the effect does start from any amount of radioactive materials. There is a very significant amount of work still going on at various laboratories on both the somatic and genetic long-term effects of radiation.

Mr. Daddario. I think it does help if we could understand at this moment the best information we have allows you to come to this conclusion, and that we feel it is reliable, but that we are continuing research. We are not just taking these figures as they stand. It is our ultimate objective to have this refined to the point where we can be positive because of research that this is, in fact, a safe level?

Dr. Lieberman. Yes, there is continuing extensive research in these areas.

The growth of the industry, obviously, has precipitated questions on our capability for managing the wastes that would be associated with this growth. The major considerations in this whole area of waste from the growing atomic energy industry is related to wastes that are associated with the reprocessing of the irradiated fuels. Back as far as 1959 and before that, as you indicated, Mr. Chairman, the Joint Committee on Atomic Energy had extensive hearings on this subject, and specifically to try to get a handle on what we would have to contend with in the future.

I might point out that estimates were made at the time of those hearings with respect to waste volumes that we would have to contend with in the future, and by 1980, for example, there were expected to be something like 40 million gallons of these highly radioactive wastes that would have to be handled.

In the past 8 years, as a result of improvements in the technology for reprocessing these irradiated fuels, there have been significant reductions in the unit volume of waste produced. Whereas, for example, in 1959 and 1960 for every ton of irradiated fuel that was processed we were producing something like 1,500 gallons of highly radioactive waste that had to be managed, at this point in time we are producing only about 100 or 200 gallons of highly radioactive wastes per ton of fuel processed. So, even though the estimates for power growth have gone up, the estimates of the actual volume of wastes that we would have to handle have gone down to the point that now—this now includes the introduction of breeder reactors into the nuclear power economy—it is estimated that in the year 2000, we would have to handle something like 80 million gallons of highly radioactive wastes. This is quite comparable to what is now being handled as a result of the Atomic Energy Commission's production operations via tank storage at this point in time.

I think this is simply one indication that in assessing the technology that we used in the past and we are now developing in relation to the future problem, we are quite confident that, indeed, we do have in hand or will have very shortly as a result of the development work being done, the capability adequately to manage these wastes in a safe manner.

Dr. TAPE. I think this is an important point, Mr. Daddario, in developing the confidence you are talking about, because what Dr. Lieberman is saying is that with all of these projections, growth, and so on, the technology which is in hand today will give us a volume which we have already handled in operations to date. So, we are not looking at anything which is drastically different from the experience we have already had.

Mr. DADDARIO. You can expect comparable improvement in your ability.

Dr. TAPE. This does not mean you give up trying to make even better technological improvements.

There is another point which we have glossed over, that is at the heart of the whole waste management problem with respect to nuclear power. In the nuclear power system, the waste is created within the core of the nuclear reactors where proper management is really keeping that waste under control at all times.

The big waste problem is not the dissipation into the environment; we are not using the environment to get rid of it. It is quite a different approach to those followed in the past with other processes. We didn't start out to use the environment to get rid of the waste. The philosophy was to control it. It is controlled right through the entire process.

Mr. DADDARIO. The problem comes as you bring it from place to place, how long you have to keep it there, and how dangerous it becomes.

Dr. **Tape.** Those are problems at each stage in the process, from the plant to chem processing plant, to intermediate storage, to permanent storage. But it is important to note that the way in which you handle this is through control, and because it is concentrated and packaged it can be controlled.

Mr. **Daddario.** The problem that has bothered me is that "permanent" sounds fierce enough from a problem point of view but when you go from "permanent" to "perpetual" that is really a little frightening.

Dr. **Tape.** Perpetual burial doesn't frighten me when you consider how small a quantity you are talking about in the perpetual burial phase.

Dr. **Lieberman.** I would like to comment on that point.

Mr. **Daddario.** Won't you come to that?

Dr. **Lieberman.** Yes, I will.

I am taking more time in summary than I had proposed. I might skip some specific topics but if there are questions we can certainly discuss them.

Let me get to the long-term aspects since you have alluded to this point, Mr. Chairman, in handling and managing these high-activity wastes.

Up to this point these wastes have been evolved primarily at the Government-owned fuel reprocessing plants located at Hanford, Savannah River, and in Idaho. There is now commercially operating a relatively small reprocessing plant in New York and there is one proposed for construction by the General Electric Co. in the State of Illinois.

At these major AEC installations over the past 20 or 25 years the storage of these wastes in specially designed and located underground tanks has been satisfactory. There have been instances where wastes have had to be transferred from one tank to a standby tank, but I think in general one can fairly state that this operating experience has shown that the tank storage at these locations is a satisfactory way of handling these wastes.

However, because of the long-term implications involved, the nature of the radioactive materials included in these wastes, strontium, et cetera, which means that you have to be concerned about these materials for literally hundreds of years, it would lead us to at least an indication that there might well be some limitations to tank storage, even though from a practical engineering standpoint one can come up with a system that would include transfer from one tank to another.

This concept of having to do something "permanent" with these materials is not something that is new to us. I recall one of our early sessions in 1955 carried out under the sponsorship of the National Academy of Sciences under Dr. Harry Hess of Princeton in which we considered this problem of long-term handling of these wastes.

Out of this meeting, and in further subsequent discussions, the concept of solidifying these high-activity wastes, converting them into a form whose mobility was minimized, and then taking these materials and putting them into an environment that was essentially separated from the biosphere, if you will, seemed to be a reasonable and adequate long-term—and I might even say perpetual if you will allow me to define it in terms of geologic time——

Mr. **Daddario.** What is geologic time?

Dr. **Lieberman.** I will do it this way, Mr. Chairman. The salt formations in which we conducted field tests out in Kansas have been there for a long period of time, for geologic periods of time, and I think we have every reasonable reason to believe they will continue to be there for roughly equivalent periods of time. Therefore one can conceive, as I think we have and are demonstrating in an engineering way, of techniques for solidifying these highly radioactive materials, minimizing the volumes so that by the year 2000 we would have something less than 1 million cubic feet produced of these solidified wastes, taking them, then, and putting them into the salt formations for long-term or "permanent" storage. These salt formations, which by their geologic nature are not associated with sources of water supply because if they were the salt wouldn't be there, have other very useful properties. The material behaves something like a self-sealing gas tank. If one puts this radioactive material in solid form in that kind of environment he can be reasonably sure that for the lengths of time we have to be concerned with this material it is adequately managed. The development and demonstration of this technique represents a major undertaking of our research and development program.

We are now demonstrating in an engineering scale plant out at Hanford three processes for solidifying these wastes. We are just completing field tests in the salt mine in Kansas where we have used irradiated fuel elements to simulate these waste pots, to corroborate our laboratory work with regard to the behavior of salt under temperature and radiation conditions, and I think it is reasonable to state that this technology indeed is in hand and it is being demonstrated. The final engineering reports on this work will be available within a matter of the next year or two.

Mr. **Mosher.** When you say 1 million cubic feet, over what period of time?

Dr. **Lieberman.** As of the year 2000, with the installed capacity of nuclear power that would be included by that time, we would be producing in this solidified form something like 90,000 cubic feet per year, but by the year 2000 we would have accumulated, as a result of everything that has gone on, all the nuclear power which has been produced up to that point, with all the waste processing, something like 960,000 cubic feet.

That 960,000 cubic feet would be the amount we would have accumulated by the year 2000, based on the estimates of the growth of nuclear power.

Mr. **Mosher.** Then there would be continual production?

Dr. **Lieberman.** By the year 2000, this would be roughly 90,000 cubic feet per year.

Mr. **Mosher.** That would not appreciably increase after that?

Dr. **Lieberman.** No. It would increase as the nuclear power growth went up. Our crystal ball looking stops at the year 2000, but if the nuclear power installed were to double over the course of the following 10 years, then there would be a proportional increase in the volume of solids we would have to handle.

Let me indicate it in terms of how much salt mine space you would need for this operation. The estimates we have made would indicate that by the year 2000, and Mr. Belter can check me on this, something less than 3 acres of salt mine space per year would be required.

As you are probably aware, there are substantial areas of the country in which these salt beds do occur, and this is a relatively small percentage of the space that is mined out just in salt production per year, so we do not see any bottleneck in that respect.

Mr. **Daddario.** You talk about 3 acres. Even though you say you do not see any bottleneck in that regard, it may be significant to ask why you changed your figure? You and Mr. Belter wrote an article, "Waste Management and Environmental Aspects of Nuclear Power," where you say that the amount of space required would be 1.2 acres.

Your statement here at page 2 states 2.8 acres. You now speak of 3 acres.

Dr. **Lieberman.** Yes.

Mr. **Daddario.** Even though the bottleneck may not occur at 3 acres, the figure needs explanation.

Dr. **Lieberman.** The estimates of the volumes of waste at the time that that article was prepared did not include the introduction of the breeder reactors into the economy.

With the introduction of breeder reactors, because of the greater extent to which the fuel is utilized, what we call higher burnup of the fuel, the unit activity in the volume of waste would be higher and perhaps would have to be diluted to take care of some of the temperature problem, so the estimates of the volume of wastes have gone up because by the year 2000 we anticipate indeed there will be a significant introduction of the breeder reactors. This increase, then, is reflected in a proportionate increase in the space required to handle it.

Mr. **Belter.** The time that article was written was before the revised nuclear power estimates which have just come out during the past 6 months. By the year 1980 there has been substantial, about 25 to 40 percent, increase in these power estimates.

What this means is that the rate of nuclear power growth really will be increasing that much more rapidly, so we will have on the line by the year 1980, say, approximately between two and three times as much power, nuclear power, which would be carried over to the year 2000. Because of having that much more power we will be turning out that many more megawatts and we will have that much more fuel load which has to be reprocessed.

Dr. **Lieberman.** In essence, at the time of that paper our estimate of the growth of nuclear power was faulty.

Mr. **Daddario.** You were talking about a different set of statistics?

Dr. **Lieberman.** That is right.

Dr. **Tape.** I might point out that sometimes we are pretty brash making forecasts this far in advance. Given the nature of the problem we have to do our best job at the time, looking toward the year 1980, 1990, 2000, and so on. This is true for this aspect of the problem and true for the developmental side of the problem. Modern-day technology takes a long period for development and a long period to introduce it into the civilian economy, and so on. We have to make estimates like this and do the best job we can.

Mr. **Daddario.** No one can find fault with it. I think it is important that as we see the situation differently we ought to talk about it a little bit so people can understand why there has been an adjustment.

Dr. **Tape.** We need to recognize changes when they occur and update accordingly.

Mr. **Lukens**. Is there an advantage to be gained in radioactive dissipation with the solid storage as opposed to liquid storage?

Dr. **Lieberman**. Yes; I think there is an advantage to be gained, but not in terms of the dissipation of the radioactive materials.

Mr. **Lukens**. We are talking about hundreds of years.

Dr. **Lieberman**. The radio-nuclide doesn't care whether it is in a solid matrix, liquid, or whatnot. It has its own clock and nothing can change it. It will take the same length of time to decay whether it is down in a salt mine, in a tank, or no matter where you put it.

Mr. **Daddario**. You referred to the word "manage", that you could manage it under these circumstances. Are you talking about managing it without people? Can you put it there and you do not need people constantly to keep tabs on this?

Dr. **Lieberman**. I suppose scientifically one could mount an argument for saying once it is put in this environment you can walk away and forget it. I would venture to say for practical purposes that there would have to be some measure of continuing surveillance over this material. If I have a facility out in Kansas I would not want it arranged so people would just walk in and out of it.

The kind of manpower and the amount of manpower that would be required to do this would be minimal. I do not think I can visualize a situation where we put it in a salt formation and literally walk away from it.

Mr. **Mosher**. I am familiar with a plant that is shown here on the map in the Lower Peninsula of Michigan, but in the northern part of the Lower Peninsula. How are the wastes transported from there to wherever you take them? In what form do they leave that plant and how often?

Dr. **Lieberman**. As Dr. Tape indicated, the high activity wastes we talked about here are not evolved in the plant to which you refer, which is what we call a water reactor. The fuel elements which produce the energy leave the plant in a solid form which is identical to the way they came in with one obviously very significant difference. When they came in you could handle them directly with gloves. When they go out they have to be in substantial shielded casks because they are highly radioactive.

The fission products, which really constitute the wastes and are really the things we have to control, are contained in these solid metallic fuel elements that are transported either by rail or by truck in specially designed casks to go to a fuel reprocessing plant which may be located in New York, Illinois, or some other place, and it is at that fuel reprocessing plant location that these wastes are evolved, so the transport is a significant function involved in this whole fuel cycle management business.

In addition to this high activity waste, within the plant there are components and facilities for handling low activity wastes. There are evaporators for certain types of liquid effluents, or, for example, if you have a laundry associated with the plant and things of that sort. We end up with what we call low activity or intermediate level activity wastes. You may have an ion exchange system or some other process to purify these wastes. Eventually you have to get rid of the ion exchange resins. These are packaged and also transported to a commercially available burying ground. There are five of these.

I have the location of these somewhere in my notes. They are specially located installations which are regulated either by the State or the Atomic Energy Commission. They can receive this kind of radioactive waste.

In general I would indicate that there is essentially no radioactive material disposed of onsite at a power reactor except for those effluents which have gone through processing and are deemed safe to release to the environment.

These latter categories include both liquids—no solids because in every case I am aware of they are shipped off site—both liquids and gases.

The statement I made at the outset of my remarks, that these releases are well within acceptable limits for continuous exposure, would be the thing that would apply here.

I might also say one other thing which I think is important. The AEC regulatory people, and I am sure this also applies to the industry, do not look at those radiation protection guides and limits as something you should build up to. From a policy standpoint, if you will, the effort is made to keep the quantity of radioactive materials that are released to the lowest practicable minimum. Certainly from a safety standpoint they have to be within these prescribed limits.

Mr. **Mosher**. In this transportation by rail and highway I assume you are confident that you have adequately guarded against accidents and all that sort of thing when you refer to these casks. Have you had adequate experience which demonstrates that?

Dr. **Lieberman**. We have. Rather than going into detail if you would like I am sure we can provide this information for the record.

I would simply say in summary fashion that our transportation experience has been quite excellent.

There have been accidents but in all of our experience there has been no individual in the public adversely affected.

There have been situations where, for example, in the worst situation I can recall, to close a truck terminal for a period of time and clean it up.

In connection with this question of transportation again this goes back to identifying the problem and assuring that you have the technology to cope with it.

We carried out a very interesting and very useful operations research study of trucking radioactive materials. This was done for us by the Johns Hopkins University. We utilized the accident records we got from the ICC for large truck movements and related these accidents to the season, the day of the week, hour of the day, geographical area, road type, and so forth. We identified out of that what kind of accident rate we might expect. What are the technological factors we should be looking at? This goes back, in addition to the requirements for a cask for shielding and protection against radiation, to carrying out a program to drop test casks to see whether we can model the behavior of casks under impact and fire, and this work has been going on.

Another example is the project we carried out in cooperation with the Transportation Corps of the Department of Defense in which a loaded vehicle was crashed to measure what happens and see how these containers behave.

Transportation is an important factor and in general I would indicate that I think our cognizance or recognition of it as a factor has been quite extensive. What has been done, and the experience record, logically leads to the conclusion that we have this factor in hand.

Mr. **Mosher**. Mr. Daddario, this is a practical example of the advance assessment of technology you have been talking about.

Mr. **Daddario**. It does fall into that area.

You have not had necessarily to simulate accidents. We have a chart here which shows there have been 171 incidents during transportation on road, rail, air, sea, et cetera. You have actually had practical ways to learn about the problems.

Dr. **Lieberman**. Except most of these have been relatively minor. Dr. Tape also pointed out to me, and I failed to say this, that the Interstate Commerce Commission, Bureau of Explosives, has had a vital role to play in this whole transport business. This should be stated for the record.

Yes, we have had that experience but in these accidents there was not the kind of instrumentation to enable us to understand what kinds of forces were involved, how the energy distributed through the whole transport system, and things of that sort. As part of our safety program we think it is essential that we get a good clear understanding of the phenomena which are associated with these accidents even though the likelihood of their ever occurring might be extremely small. This is part of the philosophy, if you will, which in large measure has contributed to the success I think our record indicates we have achieved.

Dr. **Tape**. The point is that one takes advantage when there are accidents to learn as much as one can.

On the other hand you do not wait for the accidents to provide the information needed for the future. You take advantage when you are in the unfortunate situation of an accident. You do not wait for it in order to get on top of the problem, however.

Mr. **Daddario**. I understand that. I brought out the 171 accidents just to show you have been able to handle it, and the fact that these have been relatively minor.

At the same time the possibility exists, and it is important for us to develop the best techniques possible.

We could probably keep you at the beginning of your statement for the rest of the morning, but I do think we had better move along.

Any points we miss we can come back to you later.

Dr. **Tape**. We will be happy to supplement in any way you would like, Mr. Chairman.

Mr. **Daddario**. Proceed.

Dr. **Lieberman**. Let me, then, just wrap up what I think might be useful for the committee and perhaps will provide basis for further discussion.

First I would like to emphasize the point that Dr. Tape has made, regarding the preventive rather than curative approach. This has been a vital factor in our setup.

While I recognize that the industry and its development is unique, and it has been under Federal control, the fact remains that the problems in this area were identified, the phenomena associated with them and they were explored, and there were adequate resources made available to do this. The definition of the problems and the understanding of the phenomena was not done on a unilateral basis. We worked with expert groups, and this goes back to when we first anticipated stack effluent problems and the establishment of a stack gas problem working group to be sure we had the kind of definition of the problem that was required in order to say what kind of technology we needed to take care of it.

As an example, out of this kind of approach came the development of a high efficiency filter to specifically cope with the problem of removal of small particles from air and gas streams.

Incidentally, this filter now is used in hospitals, telephone exchanges, breweries, and so on.

The fact remains, having defined the problem, understood the phenomena associated with it, behavior of the material involved, we could do something about it.

The other observation I would make would relate to the utilization of related existing competencies in other organizations. I think this is a tribute to the outlook which my employers had when they said "Let us not build up a competency in meteorology, geology, fish and wildlife, but go to these agencies and get them to help us." I think this has stood us in good stead. We have had assigned to us on a full-time basis an employee of ESSA, a meteorologist, a geologist, and so on. At Los Alamos and at Hanford and Oak Ridge in the early days we had Public Health Service employees assigned to work there, not only benefiting us but they got trained in the business, too. I think this was extremely important and has contributed to the advantageous posture I think we are in now.

On our relationship to other agencies of Government—at one time there were discussions of jurisdictional problems. Who controls here? Was it the Federal Government or the States?

In setting up groups like the Mohawk River advisory group, an advisory group on the Savannah River, and others, we didn't worry about jurisdictional questions. We went to the State organizations, State health departments, conservation departments and worked with them to get them to understand what we were trying to do and to take advanage of the competencies and information which they had because they lived at the place. I think this was extremely important in helping to develop our programs and approaches to these problems.

The next observation I would make is in connection with our work with the universities. By assigning to universities, under contract, specific research and development, we not only had the advantage of slave labor, if you will excuse the expression, but we trained people who are now in our program and are contributing significantly to our continuing work in this area.

The development of technology that Dr. Tape mentioned I think is extremely important. This high efficiency filter is one example. The development of unit operations, borrowing from the oil industry and applying hydrofracturing techniques, solidification and the salt business, represents the kind of work that can develop a technology to cope with the problems. I think this is tremendously important.

Lastly, I think it is important to note the fact that we have had the continued observation and cognizance, and the support, of an informed congressional committee, the Joint Committee on Atomic Energy.

The National Academy of Sciences, and its constituent organizations such as their Earth Sciences Division (we were one of the agencies instrumental in establishing this group, their Committee on Oceanography, their Committee on Sanitary Engineering and Environment have been consulted and involved. By utilizing these competencies we obtained significant additional ability to cope with our problems.

With that, Mr. Chairman—I am sorry the summaries took as long as they did—I hope we have given you a reasonably good idea of our participation in and contribution to this environmental pollution control situation.

Mr. DADDARIO. First of all I would like to say that in that part of your statement which refers to thermal effects of steam electric generating plants, Senator Muskie also will have hearings on that in the near future. We will look to them for the development of that particular aspect.

Dr. LIEBERMAN. It was for that reason that I skipped this.

Mr. DADDARIO. We think it is important for congressional committees to coordinate their activities and not run one over the other, and we can be helpful in that regard.

We are talking about the preventive techniques you developed. How do you go about obtaining the independent assessments and reviews of these procedures when most of the knowledgeable people involved are working within the AEC program? Who arbitrates? How do you handle that part of it?

Dr. LIEBERMAN. I think there are at least two things that might be said here, Mr. Chairman. First of all, as you know, there is a regulatory side of the Atomic Energy Commission which is physically separated from us. They are in another building in Bethesda and we are out at Germantown. Indeed they are independent. I can speak from direct experience in working with them.

However, we do work with them as they discharge their responsibilities in controlling the industry and granting licenses for nuclear powerplants and fuel reprocessing plants. We get from them the kinds of questions that they feel need answers in order for them to carry out their responsibilities. I think this is one way in which we get this independent input and assessment.

Another very important way is one I alluded to very quickly. When we have gone over to other agencies like the Public Health Service or the Geological Survey or the Bureau of Mines we have essentially asked them to tell us what are the problems we will have to contend with here? We are not in the business of telling them how to do their geology or meteorology.

By doing this we have also been provided an independent assessment of our activities.

The third one would be in dealing with organizations like the National Academy of Sciences, an authoritative group to which we have looked to review our research and development program and to help us identify requirements in an independent manner.

I think that these three are simply examples of how we accomplish that very important matter.

Mr. **Daddario.** Have you in fact used the Academy of Science for this purpose? Do you mean by what you have just said that in the event it did come about you would use them?

Dr. **Lieberman.** We have in fact used them over the years.

Mr. **Daddario.** Could you provide for the record an example or two?

Dr. **Lieberman.** We can provide for the record copies of some reports that the National Academy of Sciences have produced at our behest. These go all the way from assessment of disposal of radioactive wastes in the oceans to disposal in salt, or deep underground formations.

Dr. **Tape.** In that connection, the Commission has been looking at what might be called the continuing relationship between the Academy and ourselves in this area of radioactive waste management.

What we are doing now is discussing with them the creation of a new group in the Academy which has a somewhat broader scope than we have used in the past. This has not been completely defined as yet but I could probably provide you a draft which might be useful in this connection.

Here is a case in which we indeed would like to see the independent input that you were talking about having the broadest possible representation of disciplines which would be brought to bear on this kind of problem. I think it will be useful to the Academy and useful to us to have someone who has this focus on a continuing basis.

Mr. **Daddario.** Commissioner Tape, it is a very interesting proposal you have just talked about. From it I understand that this group when put together, as you intend it to be, will be able to independently come to a judgment about something that ought to be done rather than have you ask them.

Dr. **Tape.** What we are starting out with in the NAS proposal is that this committee of the Academy become fully familiar with: our own operational plans; the way the AEC itself has been doing business; what our operational practices have been; the plans for waste management; surveillance activities we have had; and the research and development programs.

I think you can see that in our bringing them into the picture we hope to expose them to the broad gamut of operations and research.

There are some restrictions. For example, we cannot have the committee involve itself in specific licensing operations because that is a specific function of the Commission's regulatory role. Although they can use those cases for examples in terms of the way things develop we want to be sure we do not involve them in the regulatory sense. Research and development and planning for the future is involved and we look to this as a continuing relationship where we will have the option of their looking at both general and specific aspects.

Mr. **Daddario.** We certainly would be interested in getting your views on that.

Dr. **Tape.** These are preliminary. Discussions are underway with the Academy.

The group has not been appointed. The point here is that the older committees which have been involved, as Dr. Lieberman was saying, have at times addressed themselves to certain specific questions. Here we want a little broader consideration.

(The proposal referred to is as follows:)

NATIONAL ACADEMY OF SCIENCES—NAS–NAE ENVIRONMENTAL STUDIES BOARD

Proposal for Advisory Services to the Atomic Energy Commission Concerning Long-Range Radioactive Waste Management Plans and Programs for an Expanding Nuclear Energy Industry

Program Administration:

C. K. REED,
Executive Secretary, NAS–NAE Environmental Studies Board.
Phone: 961–1706.
Contract Administration:

B. L. KROPP,
Deputy Business Manager, NAS–NAE–NRC.
Phone: 961-1213.

PROPOSAL FOR COMMITTEE ON RADIOACTIVE WASTE DISPOSAL ADVISORY TO THE ATOMIC ENERGY COMMISSION

This proposal is submitted in response to discussions between representatives of the Atomic Energy Commission and the National Academy of Sciences concerning utilization of the services of the Academy in connection with the disposal of radioactive wastes.

If this proposal meets with AEC approval, the Academy would preceed with the appointment of an appropriate committee to review and advise the AEC concerning long-range radioactive waste management plans and programs for an expanding nuclear energy industry. This primary task would include the general assessment of the adequacy of the present and projected technology in relation to meeting long-range health, safety and other environmental requirements, and the identification of new research needs.

The general scope of the Committee, as stated above, may be modified or extended as needed by mutual consent of the Commission and the Academy. Specific studies would be undertaken on the initiative of either the Commission or the Committee following agreement of representatives of the Academy and of the AEC on the objectives of such studies. It is understood that the Committee would not be requested to provide advice on specific cases which normally come within the purview of the AEC Advisory Committee on Reactor Safeguards.

The NAS–NAE Environmental Studies Board would periodically review and guide the work of the new Committee. The general concept for organization and operation of the Committee would be as follows: The Committee membership, which shall be discussed with the AEC, would include professional competence from essential areas such as health physics, chemical engineering, environmental engineering, meteorology, geology, hydrology, industrial hygiene, oceanography, and geological sciences. Where necessary *ad hoc* panels would be established to develop specific areas essential to the Committee effort. AEC will be given adequate prior notice of each Committee meeting and invited to be represented by one or two liaison representatives.

Throughout the conduct of its work the Committee would depend upon the cooperation of the Commission, its staff, and its contractors to furnish available information and data as these may be required. The initial orientation task of the Committee would be to become familiar with both AEC and industrial waste operational practices; plans for waste management and associated surveillance activities; and research and development programs. A series of briefings would be required, and it is contemplated that the Committee, or particular members thereof, would spend sufficient time at disposal sites reviewing the work already completed or underway on the various waste management approaches. The next task of the Committee would be to compile a comprehensive listing of various topics within the scope of the Committee's charter, that could be considered by NAS and AEC as additional topics for study by the Committee.

The Committee's report(s) would be furnished to the Commission for its consideration and any distribution beyond the AEC. The time schedule for reporting would be worked out with the Commission and the Committee in the course of the initial meetings.

Funds are requested to cover general operating costs of the Committee for a two-year period from March 1, 1968, to February 1970, at a level of about $50,000 per year. It is expected that special studies or tasks will be identified as the Committee proceeds with its work, which may require separate, additional support.

Mr. **Daddario**. Could you go into your relationship with other agencies a little bit? You have talked about ESSA and others such as HEW. Is this a relationship where you call them in when you feel you need them, or do you have a committee structure where there are regular meetings and regular opportunities for people to come to judgment about these things?

Dr. **Lieberman**. As I indicated, and this goes back in history, in certain instances we have something even better than that. There is an employee of ESSA paid by ESSA who has a desk right across the hall from me who then becomes familiar with our programs and problems, but then he has access on a continuing basis to all the competencies and facilities which exist in that organization.

As a result of that very close working relationship, and I use this only as an example, at the National Reactor Testing Station in Idaho we have had, ever since it has been in operation, an ESSA group which is doing research and development in meteorological diffusion at that testing station for our purposes, but it is also useful to the industry in general.

I might also point out, again in this specific area, the working relationships have been intimate and extensive. When we first asked them to put out a document called Meteorology and Atomic Energy, back in 1955 or 1956, that document—and this might be a self-serving declaration but it is a fair one—I think represented a major contribution to air pollution meteorology, not only for the Atomic Energy Commission and the nuclear industry but industry in general. They are now completing a revision of that document.

The working relationship, therefore, is far from haphazard. There is AEC money which goes to these agencies when it is required to support research and development by those agencies. I could list the agencies with whom we work in this regard. They cover almost every agency which has anything to do with the environment—Fish and Wildlife, Public Health Service, Geological Survey, Weather Bureau, and many others.

At this point in time only ESSA and the Geological Survey are represented by actual employees assigned to us, but at one time this also included the Public Health Service.

I can hardly overemphasize the importance we attach to this kind of relationship and the value that has accrued from it.

Mr. **Daddario**. Let us take the Fish and Wildlife reference, which I think is at the bottom of page. You say:

> The Commission takes into account reconcentration aspects in setting release limits to the environment from operating facilities. U.S. Fish and Wildlife Service is regularly consulted on questions in this area.

Who has the veto if there are disagreements? How do you come to a judgment about what you can or cannot do?

Dr. **Lieberman**. Let me say one thing by way of introduction to this point, Mr. Chairman.

First of all, the Fish and Wildlife Service at its laboratory, the one I am generally familiar with being in North Carolina, has done an extensive amount of work on the behavior and uptake of radioactive materials by various marine organisms. This has provided the basic information which is required to do the kind of thing indicated in the statement.

From the standpoint of the regulatory function of the Commission, when they get an application for a license for a commercial plant they routinely send these applications over to the Fish and Wildlife Service and ask for their comments. As far as I know there has been no instance where the Fish and Wildlife Service has come in with a comment which indicates that something more has to be done where this has been overriden by the regulatory people.

I think the answer to your question is, therefore, that if indeed there were an argument that developed in a particular situation, while the Fish and Wildlife Service as a result of this relationship would not have a veto power, their comments would be considered and would be made available to the public in accordance with regulatory procedures. Insofar as this comments relates to radioactivity and radiological safety, the AEC regulatory function would be such that what the Fish and Wildlife Service means would be incorporated in whatever requirements the regulatory people came up with and which a licensee would have to meet.

Mr. **Daddario.** The Fish and Wildlife people probably would have to depend pretty much on information you give them as to the effects of this.

Dr. **Lieberman.** No, because they have done work in this area themselves with their own people. They have carried out in their laboratories uptake studies and reconcentration studies of various radioactive materials. They have done it in the past and so far as I know they are continuing this work.

This is another example of not building up a tremendous duplicating competency within our own in-house organization in a specialized aspect of the business.

If radioactive materials might get to where fish will get to them we ought to know how they interact and we ought to go to the people who have the experience and competence in these areas. This is what was done. This does not mean the Fish and Wildlife Service are the only ones who have been working in this area. The comments and views that the Fish and Wildlife Service would come up with in this connection would be based on their own knowledge, experience, and competence.

Mr. **Daddario.** We can take that as a somewhat typical example of a Government agency with which you have worked over the course of time and which has developed an ability to look into radioactive problems and to come to a judgment as to how they can accomplish their own missions. Then you work with them in both providing the answers and coming to solutions.

Dr. **Lieberman.** That is quite right, Mr. Chairman.

Mr. **Daddario.** Dr. Lieberman, it probably comes as no surprise to you that we might on occasion have some national coal policy newsletters come to this committee. There is in here a statement about a

General Electric permit which I would like to read to you and would like your comment.

It says:

> The Atomic Energy Commission this week granted to General Electric a provisional permit to construct an irradiated nuclear reactor fuel reprocessing plant in Grundy County, Illinois, adjacent to the three Dresden nuclear power stations of Commonwealth Edison Company. One condition attached to the construction permit was that General Electric show proof that the land on which nuclear waste, created in the plant operation, will be stored has been transferred to the State of Illinois, which will exercise permanent control.
>
> The plant, to be known as the Midwest Fuel Recovery Plant, will have a capacity for processing compacted uranium dioxide at an annual rate of 300 metric tons of uranium. It is designed to recover plutonium, neptunium and uranium from fuels which have been used in nuclear power plants.
>
> Highly radioactive wastes which will be produced are to be reduced to solids, canned and placed in storage basins below ground level and under cooling water. Gaseous effluents from the plant operation which will be released into the atmosphere will be kept within safe levels, AEC said. In addition, AEC says the plant is so designed that the gases will be trapped inside the structure in case of uncontrolled release due to an accident of some sort.

In view of everything that we have said, we get the feeling that there is a certain amount of instability, it is more than just storing of this if you have to store it under cooling water.

Dr. LIEBERMAN. Mr. Chairman, we did not go into all the process details. We mentioned solidification and storage in salt.

Mr. DADDARIO. I understand that. I just add one further point. If you would like to just answer this for the record, you may.

Dr. LIEBERMAN. Fine. What you read there is, I believe, consistent with our approach and the comments that I have made this morning. The wastes are stored in water for an interim period because of the heat involved from the radioactive decay. It is being stored in a way that later the General Electric Co. would be able to remove it and transport it to a salt mine if that was going to be its permanent disposal place.

Mr. DADDARIO. It is not inconsistent with what you have said.

Dr. LIEBERMAN. That is correct.

Mr. DADDARIO. During this period of time there is the need for much closer surveillance than after 30 years.

Dr. LIEBERMAN. Yes.

Dr. TAPE. The point of the State control of land, for example, is indicative of public authority that has long-term cognizance of the land on which this is to be placed and you do not have to worry about a question of a private company that might move out, and so on. It is a question of looking at the permanent commitments.

Mr. DADDARIO. Once this is transferred to the State, such as Illinois, how do you stay on top of it for this period? Who checks and gives advice? What controls do you have?

Dr. TAPE. This depends on the particular State, Mr. Daddario. One of the features of the Atomic Energy Act is recognition that public health and safety matters have long been under the cognizance of the States. The Atomic Energy Act authorizes the Commission to transfer to a State certain of the Commission's regulatory authority over radioactive materials when the Governor certifies that the State has a regulatory program which is adequate to protect health and safety, and the Commission makes a finding that the State's program is adequate as certified by the Governor and is compatible with the AEC's regulatory program. The authority transferred to the State includes licensing and inspection of low level radioactive wastes. AEC, under its regulations, retains authority over wastes resulting from the processing of irradiated nuclear fuel. Thus, a State which has entered into an agreement with the AEC for the transfer of regulatory authority would supply, through its public health-radiological safety authority, licensing and inspection for low level wastes. For high level wastes, the AEC regulatory side would continue to license and inspect to see to it that such wastes are controlled in accordance with the AEC regulations. As I recall it, Illinois has not yet exercised this option; so this would be an AEC responsibility even for low level wastes.

Mr. **Daddario**. If you were to transfer this responsibility to a State, would you watch it, and if there occurred a period of political instability in that State, maybe some budgetary problems where they could not continue the maintenance control, could you then step in again?

Dr. **Tape**. Part of the agreement with a State is to maintain compatibility with the Federal program of regulation in this area. We do meet with them and go over their plans and operations at regular intervals to assure ourselves that they are continuing as they indicated at the time of signing the agreement. The Commission is authorized to terminate or suspend the agreement with a State and reassert its own licensing and regulatory authority upon request of the Governor, or upon a finding that such termination or suspension is required to protect the public health and safety. I think we would prefer to help correct their deficiencies rather than to take away authority in any sense of reverting to Federal control. As noted earlier, however, the Commission's authority over wastes from plants which process irradiated fuel is not transferred by the agreement but is retained by AEC.

Mr. **Daddario**. But one way or the other, you do have a way to pull the thing back?

Dr. **Tape**. We do have sufficient influence and control that this can be done.

Mr. **Daddario**. Dr. Lieberman, Mr. Carpenter was attracted by a magazine concerning the amount of radiation which may be harmful. Now, there are statements here about dosage levels. I am concerned about the problem. If there is an agreed-upon lifetime exposure, how do you take into consideration different parts of the country or the world where the natural radiation problem may be greater than in other parts? What happens when you need to be X-rayed, dental or otherwise, and how does this fit into this picture? How does the ordinary person, as he goes about his daily life, as he gets involved with radiation, natural and otherwise, medical, or what have you; how is he protected under this 10-percent emission or less?

Dr. **Lieberman**. As an individual, I do not think anybody that goes for a dental X-ray or a chest X-ray has any more idea than a rabbit how much dosage he is getting.

Mr. **Daddario**. Does that include the fellow who is X raying him?

Dr. **Tape**. Some.

Dr. **Lieberman**. In some, I guess that is true. Although I have the impression, as a layman in this area, that that situation is improving markedly, that the dental associations and medical associations are indeed doing a substantial job in trying to keep to a minimum the amount of exposure that is required for medical reasons.

Dr. Tape. One of the byproducts of our business has been increasing cognizance on the part of the medical and dental raidologists, X-ray technicians, the people in the field, both on the user side and on the equipment supplier side. I think the question of X-ray exposure has received much attention and, as such, is being looked at in a very concerted way.

Mr. Daddario. Because the patient does not know, as Dr. Lieberman says. It is important for those who are handling the equipment involved to understand the situation to the highest degree. The indication is not just from you, of course, but from others that this is not the case.

Dr. Tape. Actually, Mr. Chairman, I think the situation here is that levels which have been established for what you might call the manmade radiations have tried to take into consideration that the general public does receive X-rays in a medical diagnostic, or therapeutic way, and the standards do take into account some average value that might be concerned there. So that on the average these levels have tried to reflect that.

Now, what this does not do is address itself to the individual who is undergoing some rather drastic radiation therapy. This is a matter of judgment on the part of the doctor and his patient as to what is right for the patient under the circumstances.

The philosophy behind all radiation exposure is that there be some kind of a risk-benefit evaluation. The levels have been set as low as they have for the general public because it is felt that the risk at that level is far less than the benefits that are being achieved by the presence of, say, nuclear reactor plants or other applications.

On the other hand, an individual may be given a very high exposure to radiation for medical reasons if his doctors believe that such treatment is required to cure a serious malady. In this case the benefit is the possible cure of the malady and this may be much larger than the risk from exposure to radiation. This is the kind of evaluation that one makes. I think you and I mentally do this every time we may be asked "Do you want another set of dental X-rays?" And you think back as to when you had the last set and maybe you say "Yes," and maybe you say "No." So it is in that context that I think we are all much more conscious of the situation.

Mr. Daddario. I remember when I had the last one. But as I listen to you, I wonder when I am going to get the next one.

Dr. Tape. Improvements are being made. Here we know those X-rays can help us, they can find things that need to be cured, so we make our decision as to how frequently this needs to be done.

Mr. Daddario. Commissioner Tape, I think that is all well and good. Yet, it does not take into consideration the millions of Americans who do not go into this process of whether to cure or not, but who just go from day to day doing what they have to do and are X-rayed when the doctor says they ought to be, for teeth or anything else. They take whatever dosages are imposed upon them. Somehow, I would think that to be the general case and I would suspect that that would be the kind of research that you would feed into your own requirements. It would seem to me to be dangerous for you to do otherwise.

Dr. Tape. As I said, the initial reference levels have tried to take into account that for medical purposes one does have this somewhat average value that you would expect him to be receiving.

Mr. Daddario. Dr. Lieberman, doesn't this get us back to our earlier discussion. Because we are operating on information that we are confident about but which is not absolutely precise, that we ought to in all of these areas, including radiation, do the amount of research necessary to be able to come to determinations as quickly as possible.

Dr. Lieberman. I certainly think it is important that we do this research, Mr. Chairman. As I indicated, extensive work is going on. However, and this is a personal belief, I think we know a lot more about radiation and its potential effects and what to do about them than a lot of other things that we do not know very much about.

My wife, for example, is an avid coffee drinker and, if I were to ask the question "Well, is all the caffein you are taking in—does it have any carcinogenic possibilities?" I don't know whether it is known. I recall a statement made, I think it was by Dr. George Beadle, the geneticist, who is presently in Chicago, I believe, and was chairman of a group that the National Academy of Sciences had—Dr. Wolman can remember this—on the biological effects of atomic radiation. Dr. Beadle—I think he is the one—said that we are in beter shape in terms of assessing the potential effects and how to control them in connection with radiation than many other things that we accept on a daily basis. Now, once again, this does not mean that we should rest on our laurels. I think more work has to be done because of the unique aspects of this particular possible insult to use as human beings. So while I agree completely with your comment that this research has to be done to pin this down better, I am simply indicating that I think there does exist the basis for the rational development of this industry and its control.

Mr. Daddario. I find no disagreement with that. I think we are doing marvelously well. I think it is quite obvious that this is the situation. We are involved with a program which just a short while ago people could not even believe. It is now in a sense becoming a way of life. There is a tendency when this happens for us to accept things and to do less than we ought to. We do have regulatory controls which are imposed in this particular area and we, therefore, have an extra responsibility. We know it happens in any place where some heated water goes into a river, such as the Connecticut River. Everybody gets up in arms because they think of all the problems, not just those attendant to that emission, but they begin imagining everything else. This has a great effect on the whole psychological structure of an area.

I recognize your problems, and I do not in any way mean to be critical about what you are not doing. You are doing a great deal, but I do think it is important for us to understand that at a time when activities in this field become more and more commonplace and become accepted as a way of life, that is the time when it could be more dangerous.

Dr. Lieberman. This is quite right, I fully agree with that. I think this in itself is justification for carrying out the kind of research and development program that is being done.

Dr. Tape. I also think that in all of these areas, not just the radiation area but in all of them, we are operating with what I call moving targets.

We may have a certain evaluation today but additional research, development, additional experience may change our views in 10 years. That is what I consider to be a moving target.

Mr. **Daddario.** Commissioner Tape, that is exactly how I feel about it. We must recognize that these are moving targets and that there is so much to be done and we ought not to take a ho-hum attitude about this. In a sense, we are beginning to. The great part of your work is still ahead of you from the standpoint of how you will be able to come to judgments about certain things. If we can recognize that and give a continued sense of urgency to what you are doing we may all do a better job. This is partially our responsibility in the Congress. It is of vital urgency to us to accomplish more while, at the same time, making certain we are doing all these things at the highest level of competence that we can. You give every indication in your testimony today that that is what you are doing.

Mr. Brown?

Mr. **Brown.** Let me ask just a question or two on this moving target theme.

There has been a very major growth in nuclear power capacity over the last 10 years, as your chart and presentation show. You have made projections going to the next 20 to 50 years. Roughly, what kind of an annual growth rate in nuclear power capacity have you been projecting to get these figures? Or do you do it on that basis when you are estimating the amount of waste that will be produced in 1990 or 2020, for example?

Dr. **Lieberman.** Mr. Brown, one comment I would make there is that the estimate we made at the time of the paper that the chairman referred to earlier, and what happened in 1967 did not check out. The industry grew at a much more rapid rate than was estimated. I think that the estimates that are made go something like this: By the year 2000, half the installed capacity will be nuclear and by 1980 its percentage is something like maybe 25 or 30 percent.

Mr. **Brown.** The amount of total installed capacity?

Dr. **Lieberman.** The total installed capacity from nuclear sources.

Dr. **Tape.** Mr. Brown, one has to realize that we work closely with the Federal Power Commission in trying to look to the future as to what the total requirement may be. Then with some feeling for the total requirement, our people can look at various areas of the country and see to what extent we feel that the utilities may be moving in a nuclear direction or in a fossil direction. We have to make some judgments as to what this may be like at that time. Earlier when Dr. Lieberman was talking about electricity for a certain region, it was the Federal Power Commission that provided that kind of background information.

So it is a judgment, then, of two kinds: One, what the total is apt to be and, then given the total, what is the break between the two, fossil and nuclear, apt to be. That is the way we develop our estimates. You can see that some of these are pretty fuzzy. When we came out about a year ago with our 1980 estimate we said 120,000 to 170,000 megawatts. You may say to me that is a pretty wide range; but the point is that the actual nuclear power growth pattern is determined by the selections by the utilities and is not in our hands. It is the public and the utilities who make these selections.

So it has to be pretty broad. But having made the estimates, then Dr. Lieberman's group can go ahead and try to say "All right, if that is the situation then these are the quantities of wastes we might anticipate."

Mr. **Brown**. But we are talking here about a growth rate in which installed capacity is probably doubling every 10 years or something of that magnitude.

Dr. **Tape**. That is right.

Mr. **Brown**. This kind of a logarithmic curve produces tremendous changes. For example, that figure of 3 acres of salt mine, if you are doubling every 10 years you are going to need 6 acres in 10 years, and 12 acres in another 10 years.

Dr. **Lieberman**. That is the figure of 2000. You are quite right, if indeed beyond 2000 the demands for energy increase at the rate of doubling every 10 years, then that is what we are going to have to contend with.

Dr. **Tape**. There are some other problems that are going to enter into this, if you start looking that far in the future and assume a doubling every 10 years. The water that is available for cooling may be a limitation on how rapidly this expansion transpires. There may be a number of other limitations that come in. We may not be able to double every 10 years. So there are many other factors that come into this, not all related to nuclear power in any way.

Mr. **Brown**. Your projections haven't gotten to the point where you see any leveling off of this process? You have not projected a steady state situation.

Dr. **Tape**. Well, we have cut off at the year 2000 because we realize that to continue that kind of a projection is hard to rationalize right now. I think most of us—there are many utility people too—have considerable difficulty just imagining what these systems are going to be like 30 years from now.

Mr. **Brown**. Unfortunately, there are a lot of curves in our society today which have this same characteristic. What about the growth in other areas of the world, other than the United States? Do you project similar patterns of growth in installed nuclear capacity?

Dr. **Tape**. We do the same thing on an international basis, not in the Soviet bloc sphere but in the rest of the world. These percentages vary depending on the country, the locale, and so on.

One can be misled a little bit because there are areas in which the present electrical generating capacity now is very small. So they are in a catch-up role and may be doubling every 5 years. Others that are somewhat more like ourselves, then their growth rates are something like ours.

On the other hand, in certain areas of Europe where they have, for example, been importing coal from us, the economic pressures on them to go to the nuclear route are higher than they would be, let's say, in our country. So one has to make a region-by-region evaluation. One finds lower growth rates, higher growth rates, one finds some areas where nuclear is moving more rapidly than we are. England, for example, had more megawatts on the grid than we did. These are matters of time and how they develop.

Mr. **Brown**. It bothers me a little to see these projections made for a period of time which it appears as if we can handle the results, yet in a very short period of time after that for reasons which are uncontrolable, we could not handle the results. For example, the total water supply of the United States. I am becoming more and more concerned about the need to do planning for what you might call a stable state society, a condition of society in which these problems are solved rather than just saying, "Well, we cannot project what will happen in another 50 years."

Dr. **Tape**. You are suggesting consideration of a very broad problem. My memory, for example, of the population that is figured into the year 2000 projection of ours is 300 million people—for the United States.

Mr. **Brown**. And about 7 billion for the whole world.

Dr. **Tape**. We have based these evaluations on 300 million people for the year 2000. Actually, I am afraid we are going to have have many, many other problems with 300 million people that just the electrical power problem.

Mr. **Brown**. We are going to have many others. Well, I do not want to pursue this any further, Mr. Chairman, but I think it is a significant problem.

Mr. **Daddario**. Commissioner Tape and Dr. Lieberman, we still have a number of other questions which we will submit for the record. We do have two other witnesses who I hope we might hear before the day is out.

Dr. **Tape**. We would be pleased to supplement in any way that you like.

Mr. **Daddario**. Thank you. We will be in touch with you. We do appreciate everything you have said. It has been a very interesting morning for the subcommittee.

Dr. **Tape**. Thank you very much.

Dr. **Lieberman**. Thank you.

QUESTIONS SUBMITTED TO DR. JOSEPH A. LIEBERMAN BY THE SUBCOMMITTEE OF SCIENCE, RESEARCH, AND DEVELOPMENT

Question 1. The central question is whether we are proceeding to count on nuclear energy to fill our power requirements before all the dangers have been identified, techniques for eliminating them have been devised, and a complete cost-benefit analysis performed. The pressure of economics, the momentum of a commercial power reactor program, and tendency for the short term gain at the expense of long term environmental effects makes this question very important now. What research strategy is being followed to gain confidence that nuclear power will be a tolerable factor in the world of tomorrow?

Answer. The nature of radioactivity as a potential hazard to man and his environment and the importance of satisfactory radioactive effluent control were recognized when the atomic energy program was conceived under the auspices of the Manhattan Engineer District in 1942. As a consequence, careful attention has been given by the Atomic Energy Commission from the outset to the measurement, evaluation, and control of potential hazards to the environment from all Commission production and developmental activities.

In the planning and development of nuclear and reactor technology over the past 20 years, it has been a continuing research policy of the Commission to thoroughly study all nuclear safety and radioactive effluent control aspects of each project as an integral and essential part of the program. Similarly, in the planning and conduct of its waste management research and development program, the Commission has always considered the satisfactory treatment and permanent disposition of all waste materials as a prime requisite for all program activities. To assure the safe and successful development of advanced reactor and fuel reprocessing technology for the expanding nuclear power industry and in order to maintain the industry's safety record of the past 20 years, the AEC waste management program will continue to emphasize a "preventive" approach in these activities rather than a "curative" one.

Briefly stated, the "strategy" is to:

(*a*) Identify, define and characterize potential problems,

(*b*) Investigate the phenomenology associated with the possible problems,

(*c*) Develop technology as required to properly cope with the problems, and

(*d*) Apply the technology as engineered systems or processes, procedures, or other control mechanisms.

Question 2. "If" there is an agreed upon life time exposure limit to ionizing radiation, how much is consumed by natural background, x-rays for health purposes, fallout, etc.? In other words, how much leeway do we have for additional radiation from nuclear power plant effluents, bomb testing, "plowshare" type emissions, etc.? How does this leeway decrease with the predicted future growth of nuclear power?

Answer. No limit has ever been established for the maximum ionizing radiation dose a person should be allowed to receive in his life time. The Federal Radiation Council (FRC) in its first report, dated May 13, 1960, recommended radiation protection guides for the use of Federal agencies. These guides, which are generally consistent with the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP), have been adopted by the Atomic Energy Commission in the development of its radiation protection standards.

The FRC guides are applicable only to man-made sources of radiation and are exclusive of the deliberate exposure of patients by medical doctors. The basic recommendation for general population exposure is that the yearly radiation exposure to the whole body of individuals in the general population should not exceed 0.5 rem. It was recognized that under certain conditions, such as widespread radioactive contamination of the environment, the only data available may be related to average contamination or exposure levels. Under these circumstances, it is necessary to make assumptions concerning the relationship between average and maximum doses. The FRC suggested the use of the arbitrary assumption that the majority of individuals do not vary from the average by a factor greater than three. Thus, it was recommended that a guide value of 0.17 rem be used for yearly whole body exposure of average population groups.

When the size of the population group under consideration is sufficiently large, consideration must be given to the genetically significant dose. The FRC endorses in principle the recommendations of the NCRP and ICRP conecrning population genetic dose, and recommends the use of the Radiation Protection Guide of 5 rem in 30 years (exclusive of natural background and the purposeful exposure of patients by practitioners of the healing arts) for limiting the average genetically significant exposure of the total U.S. population. The use of 0.17 rem per year as a means for assuring that the individual whole body dose is not exceeded, is likely to assure that the gonadal exposure guide is not exceeded in the foreseeable future.

The following table is taken from FRC Report No. 1. Though this report is almost 8 years old, the dose estimates are substantially unchanged. The estimated per capital 30-year dose resulting from all weapons tests conducted through 1962 was 110 millirem. Atmospheric tests conducted since 1962 have not significantly increased this estimate.

Estimated annual exposure of U.S. population from all sources of ionizing radiations—Average annual genctically significant dose to the population (*millirem*)

Irradiation	
Natural sources:	
External	
Cosmic rays	32–78
Terrestrial gamma rays	25–75
Internal:	
Potassium-40	19
Carbon-14	1.6
Radium-226	2
Medical (exposure of patients):	
Diagnostic X-rays	40–240
Therapy	12
Internal (radionuclides)	1
Occupational	20
Environs (including waste disposal)	5
Other (luminous dials, TV, etc.)	2
Total	160–450

It should be noted that of the 160–450 millirem estimated average annual population dose, less than 30 millirem is attributed to the atomic energy industry. This is less than 20% of the recommended guide for the average annual population exposure.

With regard to the question concerning the predicted future growth of nuclear power, no difficulty is anticipated in maintaining the environmental exposure level well within accepted health and safety standards.

Question 3. In your testimony you discussed how the AEC obtains outside assessments and reviews. What built-in assessment mechanisms exist within the AEC? Who arbitrates disputes between the regulatory or licensing functions and the reactor development people?

Answer. There are three organizational units within the Atomic Energy Commission which have responsibilities in the licensing and regulation of nuclear power plants. These are the AEC's regulatory staff, the Advisory Committee on Reactor Safeguards, and the atomic safety and licensing boards. Each of these groups is organizationally separated from the Commission's operating organization. While they have the benefit of information which flows from the Commission's operating and development activities, none of them has any operating responsibilities. Their sole responsibility is in the field of nuclear safety and related regulatory matters. Each group is independent of the others.

Technical reviews and judgments have to be made on licensing applications by each of these groups, then the Commission, in the following order:

(*a*) Review by the regulatory staff. This is performed principally by the AEC's Division of Reactor Licensing, which calls upon many technical disciplines.

(*b*) Review by the Advisory Committee on Reactor Safeguards, as required by law. The ACRS is a 15-man committee appointed by the Commission, and is composed of scientists and engineers with extensive experience in various fields related to reactor technology.

(*c*) Review by a three-man atomic safety and licensing board after a mandatory public hearing. The board is drawn from the Atomic Safety and Licensing Board Panel appointed by the Commission. The Panel is made up of technically qualified experts and persons experienced in administrative procedures.

(*d*) Review by the Commissioners themselves—formally if an appeal is taken from the initial decision of an atomic safety and licensing board, or informally if no appeal is filed.

These reviews occur at both the construction permit stage and the operating license stage, except that a public hearing is usually not held and an atomic safety and licensing board is usually not appointed for the operating license stage. Commission-owned power reactors located at non-AEC sites and operated as part of conventional utility systems are not licensed. However, procedures which are parallel to those described above are used in the issuance of authorizations for construction and operation of these reactors.

In addition to the regulation of licensed facilities and AEC-owned power reactors operated by utilities, the regulatory staff and the ACRS review the safety of reactors owned by the AEC and the Department of Defense. On an internal basis within the AEC, any disagreement between regulatory and reactor development program personnel is normally resolved on the staff level, with the benefit of consultation with technical staff at Commission field sites. In infrequent cases, it may be necessary to refer certain technical issues to the Director of Regulations and the General Manager for resolution. Finally, any continuing disagreement could be referred to the Commission itself for disposition, taking into account the views of the independent ACRS.

Question 4: In your testimony you indicated that the AEC routinely sends licensing applications to the Fish and Wildlife Service for comments, and that their recommendations are "incorporated in whatever requirements the regulatory people came up with and which a license would have to meett".

(*a*) *What other agencies does the AEC routinely send applications to?*

(*b*) *Have there been disagreements, and, if so, who makes the final decision?*

Answer. (*a*) In conducting its safety reviews of applications for permits to construct nuclear power plants, the AEC seeks the advice of expert consultants as well as of persons of specialized competence within the regulatory organization. The regulatory staff calls upon the expertise of other Federal agencies in such fields as meteorology, hydrology, geology, and seismology.

In addition to the U.S. Fish and Wildlife Service, whose recommendations are requested with respect to potential radiological effects on fish, other marine life and wildlife, the AEC routinely uses the technical capabilities of the U.S. Geological Survey with respect to the geological aspects of the site; the U.S. Weather Bureau with respect to meteorology; and the U.S. Coast and Geodetic Survey with respect to seismology.

Where the need is indicated, advice also is obtained from other Federal agencies as may be appropriate. For example, the U.S. Army Coastal Engineering Research Center has furnished hurricane data on coastal areas for the purpose of establishing whether special protective construction should be required, and the Naval Ordnance Laboratory has furnished advice concerning the effects of explosives and missiles on structures.

In addition to consultation with experts from these Government agencies, the AEC consults with experts from its National Laboratories, the universities, and private organizations on special problems.

A copy of each nuclear facility licensing application also is furnished to the U.S. Public Health Service for its information in maintaining its state relations activities.

(*b*) The advice of other agencies in their particular areas of expertise is used in the same manner as information developed by the AEC staff to form a basis for decisions as to the adequacy of the facility's design and location from the standpoint of public health and safety. There have been no substantive areas of disagreement pertaining to the radiological safety matters over which the AEC has jurisdiction. The recommendations of the agencies which routinely submit formal reports on those projects referred to them are incorporated in the regulatory staff's Safety Evaluations, and become a part of the public record.

Question 5. Regarding the doubling of installed capacity from nuclear power sources every ten years, Dr. Tape indicated that water available for cooling may be a limitation on how rapidly this transpires. Would you expand for the record how this may be a limitation, and what alternatives are involved?

(*a*) *What are the other limitations referred to regarding doubling every ten years?*

Answer. Before responding to the importance of cooling water and the effect of its availability, on the growth of nuclear energy the growth estimates referred to in the question should be clarified. The *entire* electric generating capacity is expected to double every ten years. According to the Federal Power Commission's National Power Survey published in 1964, electric energy requirements were .85 x 10^{12} KW-hr in 1960, will be 1.6 x 10^{12} KW-hr in 1970 and 2.8 x 10^{12} KW-hr in 1980. In other words, the demand for electric power generated from all types of fuel is expected to approximately double each decade through 1980. Nuclear power is expected to have a much faster rate of growth during that period with a doubling time of roughly three years. This short doubling time for nuclear power growth is possible only because the total nuclear power generating capacity is extremely small relative to the total national generating capacity. At the present time nuclear plants produce approximately 1/1500 of the total power generated by the steam-electric plants in this country. Thus, the growth rate when expressed as a percentage increase of previously installed capacity gives a large rate increase at this time. These percentages are of little or no meaning by themselves, in analyzing cooling water requirements. Such an analysis requires estimates of the amount of heat that must be "dumped". In this regard it is essential to note that the steam cycle requires heat removal regardless of the fuel used to produce the steam. Thus, approximately until the year 1995, based on current estimates, the combined cooling water requirements of all nuclear power plants will be less than the combined requirements of all fossil fuel plants.

A quantitative answer to the question is not possible at this time, although the AEC is supporting a demonstration of a technique for estimating cooling water availability. A computer program developed at Hanford for calculating temperature increases in the Columbia River downstream of the production reactor coolant discharge is being applied to the Upper Mississippi River basin. The program, if successful, should provide the capability for computing the generating capacity the river basin can support, without the use of cooling towers, in accord with established water quality control criteria. If the demonstration is successful, the technique may be applied to other river basins in the U.S. By using this technique, coupled with estimates of energy requirements by area of the U.S., it should be possible to estimate when alternate cooling methods, such as cooling towers, are required in each area.

As an alternative to the use of cooling towers for reducing the quantity of heat released to the environment, during recent months there have been reports of using heated effluents for beneficial purposes. For example, in western New York a utility company in cooperation with the State Conservation Department has announced plans to use condenser discharge water to hatch Coho salmon eggs in Lake Cayuga, New York. Also, the use of large cooling ponds for heated condenser waters followed by use of this water for agricultural irrigation purposes is receiving consideration in the planning of a thermal electric plant in the Pacific Northwest.

Question 6. Please summarize for the record, as requested by Mr. Mosher, your experience in transporting radioactive materials. What is normally involved; what happened in the truck terminal incident; have casks containing the materials broken; what is the worst situation one might expect, and what is being done to guard against it?

Answer. Regarding the question of what is normally involved in the shipment of significant quantities of radioactive materials, care must be taken to assure that in the event of an accident, the structural integrity of the cask is maintained such that its radioactive contents are not released to the environment thereby presenting a possible public hazard, and to ensure that there is adequate shielding to prevent a direct radiation hazard to personnel in the immediate vicinity of the cask.

Both the Atomic Energy Commission and the Department of Transportation have responsibilities for regulation of the transportation of radioactive materials. Over the past several years, these agencies have cooperated with each other and with the International Atomic Energy Agency, to develop improved packaging standards and requirements for the transportation of radioactive material. Substantial progress has been made, as reflected in the AEC's regulation 10 CFR Part 71, "Packaging of Radioactive Material for Transportation", effective August 22, 1966, and Notice of Proposed Rule Making, published by DOT on January 20, 1968, which would update DOT regulations in the area of safe transportation of radioactive materials and make them compatible with IAEA and AEC regulations.

As noted in our earlier statement, the shipping experience of AEC contractors and licensees has been exceptionally good. During the shipment of about a half million packages from 1957 through 1966, there were 99 transportation accidents involving AEC radioactive materials. Of these, 70 accidents caused damage to the vehicle or package but without releasing any radioactive material from the package. In the remaining 29 accidents the package was breached; however, in 18 of these cases the released radioactive material was confined to the vehicle. No accidents have occurred involving irradiated fuel shipments in which the shipping cask was breached. With one exception, the 11 times in which radioactive materials escaped beyond the confines of the vehicle, only very minor levels of contamination occurred. The most serious accident, which occurred in January 1963, resulted from the leakage of radioactive material which had been improperly packaged. The leakage caused part of a truck terminal to be closed for several days for decontamination. This incident involved the shipment of a 13 gallon glass carboy containing 8.4 gms of plutonium and 498 gms of gold chloride in 6 gallons of acidified solution. During transit, plutonium-contaminated liquid leaked from the glass carboy (with a loosely-fitting ceramic stopper) and contaminated several trailers, truck terminals, a number of packages of other materials, and several persons handling the materials. The leakage was detected during routine monitoring of the unloading platform after the shipment was unloaded at its destination. The glass carboy was packed in a wooden box which was marked "this end up". The box also had pallets on its sides, however, and when placed on its side, the material slowly leaked out of the container. The carboy was not surrounded on all sides by an absorbent material sufficient to absorb the entire liquid contents, and therefore, was not in compliance with regulations pertaining to radioactive liquids. Neither was it in compliance with regulations pertaining to the shipment of acids. No personnel injuries resulted from this incident. The cost of decontamination was estimated to be $27,500.

The worst accident situation one might expect is generally considered to be a high speed collision of a vehicle transporting irradiated fuel with another vehicle transporting a highly flammable liquid, subjecting the shipping cask to an intense fire. To prevent the escape of significant quantities of radioactive material under these conditions, primary reliance is being placed on adequate cask design and fabrication specifications as established in regulatory safety standards. It must be demonstrated that the casks will withstand a set of hypothetical accident conditions which includes a free drop through a distance of 30 feet onto an unyielding horizontal surface, followed by a puncture test consisting of a 40-inch drop onto a 6-inch diameter steel bar, followed by exposure for 30 minutes to a fire having a temperature of 1,475° F., followed by a 24-hour water immersion test.

Question 7. Please provide more detail on other agency employees who have worked or are working within the AEC. Why was this type of arrangement started; how many people are involved; what do they do within the AEC? How is coordination maintained with the parent agency after the people have left the AEC?

Answer. One of the important and unique features of the Commission's operational and research and development activities in the radioactive waste management field has been, and continues to be, the utilization of specialized technical competencies of other federal agencies on a day-to-day direct working assignment basis. From the beginning, it was clearly recognized that the overall problem of safe handling of radioactive waste materials required the competencies of a broad spectrum of scientific and technical disciplines including the various engineering fields, the earth sciences, and the physical, chemical, and biological sciences. Accordingly, AEC funds have been allocated to a number of federal agencies to carry out specific programs in the disposal of radioactive wastes, and the associated environmental studies. Examples of this cooperative effort through the years include:

(1) U.S. Geological Survey (USGS), in connection with disposal in land and stream environments.

(2) U.S. Weather Bureau, now Environmental Science Services Administration (ESSA), in relation to gaseous and particulate effluent control.

(3) U.S. Public Health Service (USPHS), in relation to the disposal in surface streams and sea disposal.

(4) U.S. Coast and Geodetic Survey, in connection with sea disposal activities and seismologic factors.

(5) U.S. Fish and Wildlife Service, in connection with sea disposal operations.

(6) U.S. Bureau of Mines, in relation to R&D on disposal into the lithosphere.

Included in these arrangements is the assignment of technical personnel from these agencies to the AEC installations and offices on a full-time basis to assist in solving waste management problems, and to participate in R&D activities in this area. Examples include the ESSA group at NRTS: USGS group at ORNL and NRTS; the USPHS group at ORNL; and USGS and ESSA technical personnel in AEC Headquarters. Approximately 20 to 25 outside agency personnel have been involved at one time at AEC field installations and Headquarters. While technical staff change in these programs, a continuing coordination is maintained by the AEC with the U.S. Geological Survey through the Office of Radiohydrology of its Water Resources Division, and with ESSA through its Air Resources Environmental Laboratory.

The experience obtained by personnel assigned to AEC from other federal agencies has also been reflected in increased awareness by these agencies of matters relating to atomic energy, and has resulted in increased capability to be responsive to AEC needs.

Question 8. The Committee has heard testimony to the effect that a nuclear power plant under construction near Oswego, New York, (Nine Mile Point) will release to the environment each day an amount of radioactive material equivalent to 130 grams of radium. Is this a correct statement and what is the significance of this radioactivity discharge rate?

Answer. We assume that this statement is intended to mean that radioactive materials which might be discharged from the Nine Mile Point Reactor would have an impact on public health equivalent to the daily discharge of 130 grams of radium. If this is the intent, the statement is not correct. From the point of view of possible effects on health, radioactive materials released into environmental air or water are sometimes compared in terms of their maximum permissible concentrations in these media. Although this basis of comparison is generally more valid than any other that can be conveniently made, its validity may be severely limited as indicated below.

If one were to use this basis to compare with radium the various radioisotopes discharged from nuclear power reactors similar to that under construction at Nine Mile Point, the comparison would, with perhaps one exception, lead to estimates that the daily discharge of radioactivity would be equivalent to a very small fraction of one gram of radium. The exception is the discharge of very short-lived isotopes of krypton which, on this basis, might be considered equivalent to several grams of radium per day. The comparison, however, is not meaningful from a public health consideration since these isotopes of krypton undergo radioactive decay so rapidly that essentially none of the radioactivity remains after a few hours. Radium, on the other hand, persists for thousands of years

Most of the radioactive materials released to the environment by reactors of the type in question are in gaseous form and are released through tall stacks. In this manner, the radioactivity concentration is reduced by at least a factor of 1000 before the stack effluent returns to ground level. The principal radioactive constituents of the stack gas are isotopes of the noble gases, xenon and krypton. Since these gases are chemically inert, they are not taken up by the human body to any significant degree, and hence present only an external radiation hazard. Approximately 95% of the gaseous radioactivity released from reactors of this type is attributable to radionuclides having half-lives of less than 10 hours. Krypton-85, whose half-life is 10.4 years, comprises 0.007% of the total gaseous radioactivity. All other radionuclides present have half-lives less than 12 days. The discharge limit for all noble gases is generally about 1 curie per second. Experience indicates that the actual stack radioactivity discharge rate will be only a small fraction of this value. More restrictive limits are placed on the discharge of halogens, such as iodine-131, and particulates which might be present in trace quantities.

As discussed earlier, in order to determine a radium discharge rate equivalent to the above radioactivity release rates, the established maximum permissible concentrations must be considered. The MPC is listed below for each of the radionuclides of primary interest here.

Maximum permissible concentrations

Radium-226	2×10^{-13} Micro curies/ml
Iodine-131	100×10^{-13} Micro curies/ml
Krypton-85	$300{,}000\times10^{-13}$ Micro curies/ml

As indicated above Ra^{226} is 150,000 times more radiotoxic than Kr^{85}.

A comparison of the MPC for each of the above radionuclides indicates that the release of one curie of radium-226 (approximately one gram), in the form of an aerosol, would result in a radiological hazard roughly equivalent to the hazard one would expect from the release of 50 curies of iodine-131 or 150,000 curies of krypton-85. Some krypton radionuclides ($^{87-88}Kr$), have an MPC as low as $20,000 \times 10^{-12}$ micro curies/ml; however, their half-lives are only 1.3 and 2.8 hours. Thus, they do not present the long-term hazard presented by radium-226 with its 1620 year half-life.

Based on a previously noted stack release limit of 1 curie per second for noble gases, 86,400 curies of these noble gases could be discharged to the atmosphere daily. If this were all krypton-87 and 88, it could be considered equivalent to 8.6 grams of radium. This is not a valid comparison, however, because of the difference in half-lives. A more meaningful comparison is possible with krypton-85 (10.4 yr. half-life). Of the total daily discharge, 0.007% or about 6 curies would be krypton-85. This would present a radiological hazard equivalent to the release of 6/150,000 or 40 millionths of a gram of radium-226.

Considering the discharge limit for halogens and particulates, one can conservatively estimate a daily discharge rates of 0.0864 curies of iodine-131. This might be considered the equivalent of 0.0017 grams of radium.

(Dr. Lieberman's prepared statement follows:)

PREPARED STATEMENT OF DR. JOSEPH A. LIEBERMAN, ATOMIC ENERGY COMMISSION

1967 has been an eventful year in the growth of the nuclear power industry. The rate at which electric utilities have ordered nuclear power units has been remarkable, even to those who are close to the industry. By the end of 1967, approximately 50,000 megawatts of nuclear electric power hand been firmly commited, with about 2000 megawatts of plant capacity now in operation. This rate of growth is even more remarkable when one considers that it was only ten years ago (December 1957) that the first commercial plant—the Shippingport Atomic Power Station operated by the Duquesne Light Co.—went on the line to supply 60 megawatts of electricity to the city of Pittsburgh.

The most significant aspect of this nuclear power growth is that the safety and reliability of light water reactors have been established and nuclear plants now being planned or under construction are being built on the basis of their economics. While economics have played a major role in this surge of nuclear power, another advantage of nuclear power plants in that there has been a growing awareness of their advantage as clean sources of power which do not contribute to the current burden of air pollution. In fact, some utilities have chosen nuclear power and have indicated that in so doing, they wished to reduce air pollution.

The management of radioactive waste effluents from commercial nuclear power plants continues to be carried out on a highly satisfactory basis; operational records for the past 7–10 years indicate effluent discharges of less than 10 per cent of internationally accepted radiation protection limits. The following material presents summary information as requested on specific aspects of radioactive effluent control.

FUTURE WASTE MANAGEMENT PROBLEMS

With the recent surge of the nuclear power industry, some people have expressed concern that a serious environmental pollution problem would result from this growth; similarly, others have been concerned that the development of safe and economical nuclear power might be deterred because of the waste disposal problem. In this connection, the management of radioactive wastes resulting from the processing of spent fuel elements from nuclear electric power plants is a major consideration. The highly radioactive waste materials which are separated in this operation must be contained and isolated from man and his environment for literally hundreds of years. Long-term high activity waste management requirements are continually being evaluated, in order to guide the development and planning of the Commission's effluent control R&D program. This potential future problem was discussed at length, during hearings of the Joint Committee on Atomic Energy in 1959 when it was estimated that, using the then current processing technology, the volume of high and intermediate level wastes accumulated by 1980 would reach 36 million gallons.

Since the time of these hearings, extensive improvements in fuels technology and fuel reprocessing methods have markedly reduced the volume of high-activity reprocessing wastes which are generated per unit of nuclear power produced. Also, during this period of nine years, estimates of installed nuclear power in 1980 have risen by a factor of 5–7—from 25,000 MW. in 1959 to the present 120,000–170,000 MW. forecast. However, the estimated accumulated high-activity waste to be handled by 1980 has dropped by a factor of about 7—from 36 million gallons to approximately 5 million gallons. Even with the currently projected nuclear power growth rate, the accumulated waste volumes by the year 2000 are estimated at about 80 million gallons, which is comparable to the high activity waste volumes which have been satisfactorily managed by the Commission in its operations to date.

These estimates are based on an assumption that the wastes would be stored as liquids for long terms in underground tanks. However, with the satisfactory development of processes for conversion of high-level liquid wastes to stable solids (now in the engineering demonstration phase), with subsequent long-term storage or disposal ina dry geologic formation such as salt (now in the field testing stage), technology for an alternative waste management system will become available. With adoption of a conversion-to-solids waste management concept, approximately 1 cubic foot of solid waste would be produced per hundred gallons of high-activity waste (per 10,000 MW_e of fuel exposure). Preliminary engineering and economic evaluations indicate a 30-year interim storage of waste solids would be desirable before final disposal; by the year 2000, the rate of production of waste solids for final disposal or long term storage would require about 2.8 acres of salt mine floor space per year. (Additional information on salt disposal is provided under the Section "Long-term Safety of High-Activity Waste Storage".)

During the past year, various task force groups have been involved in an extensive cooperative effort to update the 1962 Report to the President on Civilian Nuclear Power. Included in this effort is a study of nuclear power growth patterns in the U.S. to the year 2020 in order to determine the size and location of fuel reprocessing plants and associated waste management requirements. An up-to-date comprehensive long-range waste management plan is also being developed, taking into account the latest power projections and fuel reprocessing plant size and locations, in order to determine the number and size of permanent high-activity waste storage sites which may be required. It is planned that reports of these studies will become available to industry and the public upon their completion.

In a related question, some concern has been expressed on the decommissioning of power reactors and the associated disposition of the reactor site, if this should be required. Nuclear power plants are currently being built using a design life basis of forty years. If, for some reason, it is decided to retire the plant, procedures for dismantling the plant would be subject to Commission approval and would be required to meet the Commission's standards for protection of the worker and the general public. Decommissioning alternatives, which require evaluation, include varying degrees of "moth-balling" the plant, i.e., decontaminating, dismantling and removing the facility (in whole or in part) and burial in place or at an approved disposal facility. Procedures for these operations must be submitted to the Commission in accord with its regulations, to assure that adequate safety measures will be taken in the course of decommissioning the reactor, and with respect to any sources of radiation that may thereafter remain at the site. Experience is being gained in moth-balling plants, such as the Hallam Nuclear Power Facility in Nebraska and the Carolinas-Virginia Tube Reactor in South Carolina, which indicates that power reactors can be decommissioned safely.

TRANSPORTATION OF RADIOACTIVE MATERIALS

The principal hazards which must be guarded against during the transport of radioactive or fissile material are accidental criticality (nuclear chain reaction) and release of radioactive material or radiation because of loss of containment or shielding as a result of impact or exposure to a severe fire. These hazards are avoided by specifying the shipping conditions, carefully controlling the quantity of fissile material which may be shipped in a single container, and by designing and fabricating the shipping containers to withstand a series of hypothetical accident conditions, including severe impact and fire. Each shipment, including container design, must meet the requirements of various regulatory agencies, including the AEC and the Department of Transportation.

The shipping experience of AEC contractors and licensees has been exceptionally good. During the transportation of this material there has been no death or injury due to the radioactive nature of this material.

A continuing research and development program is being supported by the AEC to assure that the engineering technology is adequate to satisfy the needs of the cask designer. A shipping cask design code is presently being developed for the use of the industry at the Oak Ridge National Laboratory (ORNL) in Tennessee. Other research is underway to develop a substitute for lead as the primary shielding material in large shipping casks because of its relatively low melting point. Future R&D is anticipated in the area of fast breeder reactor fuel shipping, as an integral part of the Commission's Fast Breeder Reactor Development program.

LONG-TERM SAFETY OF HIGH ACTIVITY WASTE STORAGE

More than 20 years' experience with the storage of liquid high-activity wastes in specially designed underground tanks have shown it to be a safe practical means of interim handling, but the long-term usefulness of this method may be limited. Assessments have been made which indicate that large releases of radioactivity due to geologic and hydrologic events are only remotely possible in the areas where high-activity wastes are stored. These studies have included an evaluation of the historic record of seismicity and the longer-ranging geologic record, including investigation of geologic structure; physical and hydrologic properties of sediments and rocks; and analysis of terrains in the vicinity of high level waste management operations. Studies of extremely unlikely hydrologic events are being continued in a further effort to specify their probability of occurrence and potential effects on nuclear facilities and associated waste management systems.

Due to the inherent restrictions of tank storage, such as potential leakage and the necessity of liquid waste transfer for periods of hundreds of years, the Commission has supported an extensive research and development program directed at engineering practical systems for conversion of high activity liquid waste to a solid form. Concurrently, extensive studies have been carried out to determine the most suitable geologic formations for the long term storage of highly radioactive waste material. Salt is an advantageous disposal media because of its unique geologic characteristics. Salt formations are dry and impervious to water. They are not associated with usable ground water sources and, therefore, have no connection or contact with the biosphere. Because of its plasticity, fractures in salt seal or close rapidly. Deposits of rock salt underly some 400,000 square miles of the United States and represent some of the few naturally occurring dry environments in the eastern part of the country where the most extensive development of the nuclear industry is taking place. Extensive laboratory investigations at ORNL and field studies in the Carey Salt Mine, Lyons, Kansas, are providing field data and design information required for the engineering design of a long term disposal facility for high activity waste solids.

A field experiment called Project Salt Vault, has been carried out in which Engineering Test Reactor fuel elements of high-radioactivity were used to simulate the thermal and radiation characteristics of full-scale power reactor fuel reprocessing wastes, such as would exist in a pot containing calcined solids. The field demonstration began in November 1965—four successful changes of fuel elements were completed in June 1967. The experimental results from Project Salt Vault are now being evaluated and appear most encouraging. The feasibility and safety of handling highly radioactive materials in an underground environment has been demonstrated, and the stability of salt under the effects of heat and radiation has been shown. Engineering reports of this work will be available to industry during this year and the various factors involved in establishing a prototype salt disposal facility for the storage of high activity waste solids is now under study at ORNL. The use of other geologic materials for long term storage, such as crystalline bedrock, thick anhydrite, or limestone beds is also under study.

WASTE MANAGEMENT RESEARCH

The management of radioactive waste materials in a growing atomic energy industry can be classified under two general categories. These are the treatment and disposal of large volumes of low activity gaseous, liquid, or solid wastes which are evolved during the course of operating reactors and other nuclear facilities; and the treatment and ultimate disposal of much smaller volumes of high activity wastes generated during the reprocessing of irradiated nuclear fuels. Significant progress and accomplishments have been achieved during the past ten years in developing satisfactory waste management systems for both categories of waste. The success, over the years, of the Commission's waste management program is illustrated by the excellent effluent control record which has been achieved by the industry and AEC contractors. AEC production and research facilities and large commercial nuclear power plants limit releases of radioactive materials to the environment to concentrations which are only a small fraction of internationally accepted radiation protection standards. Highlights of the R&D program are briefly summarized:

1. Advanced low-level waste treatment and disposal technology involving the use of evaporation, ion exchange, foam separation, electrodialysis, water recycle, and asphalt solidification has been developed. This technology is now being used in the design of commercial power reactor and fuel reprocessing waste management facilities.
2. The disposal of actual intermediate level waste by hydraulic fracturing of shale has been demonstrated with an engineering-scale pilot plant at ORNL. This technique which was obtained from the petroleum industry, consists of injecting a waste-cement-clay mixture under high pressure through a slotted well casing into an impermeable formation at depths of, in the case of ORNL, 700–1000 feet. A hydrofracturing plant was placed in operation at Oak Ridge during 1966 for the disposal of evaporator slurries; the use of this disposal method at other sites is now under study.
3. The Waste Calcining Facility at the National Reactor Testing Station in Idaho became the world's first plant-scale facility for converting actual high-level radioactive wastes to a safer, solid form in December 1963. This plant has continued to operate satisfactorily over the past four years, during which time about 1.8 million gallons of high-activity aluminum type waste from the reprocessing of test reactor fuel have been solidified with a volume reduction to about 1/10 the original, and then stored in stainless steel bins in underground vaults.
4. The technology for solidification of power reactor fuel reprocessing high-level waste has reached the engineering-scale demonstration phase with a "hot"-pilot plant having been placed in operation at the Commission's Laboratories in Hanford, Washington, in November 1966. Operational data are now being obtained for three waste solidification processes using full-scale high activity waste; results of this program will be available for industrial use during 1969–70.
5. ORNL laboratory and field research involving the storage of high-level waste solids in a salt mine has culminated in a full-scale field test program at the Carey Salt Company Mine in Lyons, Kansas (details provided above). Results of this field study and engineering design information will be available for industrial use by 1969.

In brief, the waste management R&D program has been and is providing the technology to engineer systems for effluent control, as required by an expanding nuclear energy industry, and no "breakthroughs" are required to meet future loads. The nature and quantity of waste effluents from thermal and fast breeder reactors are being evaluated as development proceeds on these future reactor systems.

WASTE RECONCENTRATION BY BIOLOGICAL ORGANISMS (ECOLOGICAL PROCESSES)

Certain radionuclides are known to be concentrated by biological processes in organisms. This concentration by biological processes may occur in the food chain leading to man. Four notable examples are the reconcentration of (1) cesium–137 from fallout in Caribou meat which is eaten by Eskimos; (2) phosphorous–32 by fish in the Columbia River from cooling water which passes through the Hanford production reactors and is then discharged to the river; (3) zinc–65 by shellfish, particularly oysters, that live in locations near the mouth of the Columbia River, and (4) iodine–131 in animal and human thyroid glands. The reconcentration of radionuclides in man's food chains must always be considered whenever radionuclides are released to the environment. The Commission takes into account reconcentration aspects in setting release limits to the environment from operating facilities. The U.S. Fish and Wildlife Service is regularly consulted on questions in this area.

In the case of waste released by power reactors and fuel reprocessing plants the radionuclides most likely to be reconcentrated are the iodine-131 released to the atmosphere and zinc-65 released to a water system. Evidence available from the Clinch River Study (a comprehensive stream study carried out during 1960–64 by the AEC, ORNL, USGS, USPHS, TVA, the Tennessee Dept. of Public Health, the Tennessee Stream Pollution Control Board and the Tennessee Game and Fish Commission) indicates that the maximum accumulation of radionuclides entering the Clinch River from Oak Ridge National Laboratory operations which might concentrate in the biomass constitutes only an insignificant part of the radioactivity in the river. Thus the river system can be likened to a pipeline with little retention or concentration of radionuclides in either the bottom sediments or the biota.

If zinc-65 is to be released into or can be transported to a marine environment, special consideration must be given to its reconcentration. Zinc is concentrated by shellfish (1000–10,000 times); as an activation product, zinc-65 is present in the waste discharged by several light water reactor power plants and, where required, special limits can be applied to its release.

The gaseous wastes discharged by nuclear fuel reprocessing plants may contain small amounts (below permissible limits) of tritium, krypton-85 and iodine-131. Only iodine is capable of being concentrated by biological processes; however, the other radionuclides may be cycled by ecological processes. Iodine-131 appears principally in the food chain which leads through milk to man and the procedures for monitoring this food chain are well developed. Environmental monitoring data again indicate radioactivity concentrations well below those of public health significance.

THERMAL EFFECTS OF STEAM ELECTRIC GENERATING PLANTS

The generation of electrical power produces waste heat which must be discharged to surface water or to the atmosphere via cooling towers. The average thermal efficiencies of different types of steam electric plants vary approximately as follows:

	Net thermal efficiency (in percent)
Modern coal fueled plant	38
Modern light water reactor	32
Future fast breeder (calculated)	40

Therefore, at the present time, a nuclear plant of current design discharges more waste heat to surface streams than a conventionally fueled plant of the same size because of a lower thermal efficiency. Of course, about ten per cent of the waste heat from a coal-fired plant is discharged to the atmosphere with the combustion gases, whereas essentially all of the heat discharged by a nuclear plant is through the water cooling system. When fast breeder reactors become operational, this disparity will be reduced.

Generally speaking, the problem of "thermal pollution" is one of degree. An increase in water temperatures can be harmful, or in some cases, beneficial to certain fish and aquatic life. The questions that must be answered are—what are the effects of small increases of temperature in various situations, and if harmful, how can these effects be avoided? The world's electric power demand will continue to grow at an ever increasing rate. Increasing quantities of waste heat will have to be dissipated, regardless of the proportion of coal-fueled to nuclear-fueled plants that are built. Large quantities of condenser cooling water (several hundred thousands gallons per minute for a 1,000 NWe plant of either type) will be required. As a result, the availability of adequate condenser cooling water is becoming a major consideration in selecting sites for these plants. Proper site selection requires information on the physical dispersion of heat in the environment and the effects of small temperature increases on the biota.

Research in this area has been underway for some time—for example, the AEC has sponsored research on the physical and biological effects of temperature on Columbia River for more than fifteen years. As a result, mathematical models are now being developed for predicting the increase in temperature of the receiving water from heated effluents which are discharged into rivers, lakes, and tidal systems. The reliability of these models is being determined against known conditions. A model has been used to predict temperatures of the Deerfield River downstream from the Yankee Atomic Reactor, Rowe, Mass., for example, and the predicted temperatures have agreed very closely with temperatures actually measured. This mathematical model development is being followed with an application of the model to the prediction of temperature increases throughout an entire river basin. The upper Mississippi River basin has been selected for the pilot effort.

In brief, the magnitude and severity of thermal effects problems from both nuclear- and fossil-fueled electric power plants depend on local environmental conditions. Proper site selection is becoming more important as the availability of adequate surface water supplies for condenser cooling becomes more critical. However, it should be noted that technology for solving potential thermal pollution problems is available. Auxiliary cooling systems (reservoirs, ponds, or cooling towers) can be a solution, but increased initial plant costs, in the range of 5–10%, may be required over a conventional river water cooling system. However, these costs may be offset by increased flexibility in site selection, which could result in lower costs for fuel, power transmission, and land, plus a lower heat rejection to the river.

EXTENT OF AEC POLLUTION RESEARCH PROGRAM

Extensive radioactive waste management and pollution related research and development have been carried out as an integral part of the Atomic Energy Commission's overall R&D program in order to assure an orderly growth and safe development of the nuclear energy industry. Approximately $30 million was spent during FY 1967 and about $31 million is budgeted for FY 1968 in the Commission's biology and medicine, reactor development, weapons, raw materials, production and isotopes development programs for this purpose.

Resources at AEC multiprogram laboratories are also being utilized in a number of pollution and environmental health studies being conducted in direct support of the objectives of other agencies. Now underway are two joint efforts with HEW's National Center for Air Pollution Control. One, conducted at AEC's Brookhaven National Laboratory on Long Island, is examining the economic and technical feasibility of using stable isotopes of sulfur to trace the migration and chemical reactions of oxides of sulfur emitted with stack effluents. The other is a joint program involving AEC's Argonne National Laboratory near Chicago, with the Department of Air Pollution Control of the city of Chicago and the National Center for Air Pollution Control. The objective of this tripartite effort is to develop an air dispersion model which will aid in the establishment of pollution control measures for the Chicago Metropolitan area.

At Brookhaven National Laboratory a study of the oxidation, by radiation, of iron in acid mine drainage has been conducted in order to assess the potential of this method in relation to other mine drainage treatment methods being developed by the Department of the Interior and the Department of Mines and Mineral Industry of the State of Pennsylvania.

During the past year Commission staff and representatives of the Departments of Commerce, Interior and HEW have discussed how resources available at AEC's multiprogram laboratories might be applied to pressing pollution control and abatement problems. The aforementioned programs and a number of proposed programs now being discussed have, in large part, resulted from this series of interagency meetings. The Commission is continuing its efforts along this line and is hopeful that other areas can be identified in which the experience and facilities available at its multiprogram laboratories can be used to make substantial contributions to solving pollution and environmental health problems.

Very recently, last year, Sec. 33 of the Atomic Energy Act was amended to authorize AEC to assist others on health or safety research and development problems unconnected with AEC's nuclear missions. This added authority will serve to provide AEC with more flexibility in utilizing its laboratories, facilities and talent to help others solve important national problems such as environmental pollution.

SUMMARY AND CONCLUSIONS

In summary, AEC strongly supports the efforts which are directed toward restoring and/or maintaining the quality of our environment—a goal which has become an important national objective. The Commission's program of radioactive waste control is consistent with this objective. Independent evaluations of the program that have been made over the years by various technical committees in the National Academy of Sciences, and an advisory group to the President's Federal Council for Science and Technology have shown that radioactive waste management operations are being carried out in a safe and economical manner. without effect on the public and its environment. Also, the Joint Committee on Atomic Energy maintains a continuing review and surveillance over the Commission's waste management program to assure that development of the nuclear energy industry can be carried out with full protection of the public health and safety. Waste processing technology and environmental science have been, and are being developed, which will continue to provide satisfactory pollution control systems for the expanding nuclear power industry. We believe this source of energy will make an increasingly significant contribution to the nation's energy needs and, in so doing, will lead to a major reduction of the country's overall environmental pollution problem.

Mr. DADDARIO. Our next witnesses are Mr. Kenneth Grant, Associate Administrator of the Soil Conservation Service, Department of Agriculture and Dr. Cecil Wadleigh, Director, Soil and Water Conservation Division, Agricultural Research Service. Will you gentlemen come forward, please. We regret having held you so long this morning.

Mr. GRANT. It is perfectly all right, Mr. Chairman. We have enjoyed listening.

Mr. DADDARIO. We do have a bill on the floor that comes from this subcommittee this afternoon. So we really do not have much time. We would appreciate it if you could just go into your statement as quickly as possible, Mr. Grant.

(The biographies of Mr. Grant and Dr. Wadleigh follow:)

KENNETH E. GRANT

Kenneth E. Grant was born in 1920 at Rollinsford, New Hampshire. He was graduated from Dover High School, New Hampshire in 1937 and received a B.S. degree in Agriculture from the University of New Hampshire in 1941. Following this he served as a collaborator in soil survey with the Bureau of Plant Industry and did graduate work in Agronomy. He received the degree of Master of Public Administration from Harvard University in June 1964.

Mr. Grant served in the United States Army from December 1941 to October 1945, and joined the Soil Conservation Service as a Soil Scientist at Keene, New Hampshire in March 1946. He served successively in SCS as Soil Conservationist, Work Unit Conservationist and Area Conservationist at several New Hampshire locations before joining the State Office program staff at Durham, New Hampshire in August 1955. He was appointed Deputy State Conservationist in February 1956, and became State Conservationist in January 1959. He was selected for advanced training under the Government Training Act and entered Harvard University in September 1963. In June 1964 he was transferred to Indiana as State Conservationist.

In Indiana Mr. Grant served as Department Representative on the Interagency Wabash River Basin, the Ohio River Basin Studies, and the Technical Advisory Committee on the Wabash Valley Interstate Commission. He provided leadership in developing the first Resource Conservation and Development Project in the Nation and in stimulating accelerated cooperative efforts of local, State, and Federal agencies in multiple-purpose watershed projects in Indiana. In May 1967 Mr. Grant was appointed Associate Administrator of the Soil Conservation Service.

DR. CECIL H. WADLEIGH

Born at Gilbertsville, Massachusetts, B.S. from the University of Massachusetts, M.S. from Ohio State University, and Ph. D. from Rutgers University.

Assistant Professor at University of Arkansas, studying physiology of cotton, 1936–41; joined the U.S. Salinity Laboratory, Riverside, California, in 1941 as Senior Chemist; in 1951 became head of the Division of Sugar Plant Investigations, Agricultural Research Service, USDA; in 1954 was appointed head of the Section of Soil and Plant Relationships, Soils Division, ARS, USDA; and in 1955 assumed present post of Director, Soil and Water Conservation Research Division, ARS, USDA.

Recipient of USDA Distinguished Service Award, May 1967.

Past Secretary, Past Vice President, and Past President of the American Society of Plant Physiologists; Fellow of the American Association for the Advancement of Science, and Fellow of the American Society of Agronomy.

Member of the White House Panel on Waterlogging and Salinity Problems in Pakistan, 1961 and 1962.

Currently, member of Committee on Water Resources Research and USDA representative on Committee on Environmental Quality, Federal Council for Science and Technology Executive Office of the President.

STATEMENT OF KENNETH E. GRANT, ASSOCIATE ADMINISTRATOR, SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE; ACCOMPANIED BY DR. CECIL WADLEIGH, DIRECTOR, SOIL AND WATER CONSERVATION DIVISION, AGRICULTURAL RESEARCH SERVICE, DEPARTMENT OF AGRICULTURE

Mr. GRANT. Thank you very much, Mr. Chairman.

The Department of Agriculture is happy to have the opportunity to appear before you today to provide you with a brief report on the concern and the commitment of the U.S. Department of Agriculture, in the area of environmental pollution. We commend the valuable service your subcommittee is performing by holding these hearings. Secretary of Agriculture Orville L. Freeman calls this subject a conservation crisis that is a matter of urgent public concern.

I am Kenneth E. Grant, Associate Administrator of the Soil Conservation Service, and I will present the statement for the Department of Agriculture. I have with me Dr. Cecil H. Wadleigh, Director of Soil and Water Conservation Division, of the Agricultural Research Service of USDA.

Enhancing the quality of the rural environment is of direct concern to and is a major objective of the U.S. Department of Agriculture.

The Department is also concerned with, and in cooperation with other agencies shares important responsibilities for, the quality of the urban environment.

Agriculture and forestry have a big stake in environmental pollution. This is indicated by four major points: (*a*) They are being hurt by contamination in the environment; (*b*) agriculture and forestry contribute some of the pollutants that are of concern; (*c*) work in the U.S. Department of Agriculture over the past 100 years has developed a vast array of new technology toward improving the quality of our environment, and has fostered its application on farms, ranches, forests, and in food and fiber processing; and (*d*) improved practices to further reduce pollution related to agriculture and forestry must be developed by those who are knowledgeable of the urgent needs for efficient systems of mechanized operations on these farms, ranches, and forests.

ADVERSE EFFECTS ON AGRICULTURE AND FORESTRY

Mr. Chairman, you have received ample testimony on the ample tonnage (142 million tons) of pollutants entering the atmosphere over the United States during this past year. We in Agriculture are deeply concerned over the extensive damage these airborne chemicals inflict on the trees of our forests, the crop of our fields, our ornamental plantings, and even our farm animals. Smog in the Los Angeles area is damaging pine and other trees 50 miles from the city. Years ago, stack gas emissions completely denuded forest lands around smelters. Although the worst cases of smelter damage have been corrected, extensive chronic injury to pine trees is still serious in the Lake States, the Northwest, and the Cumberland Plateau of Tennessee.

Damage to commercial crops grown near metropolitan areas is serious. Los Angeles County is often used as Exhibit A for a horrible example. But air pollution damage to crops has been found in every county in New Jersey. Cigar-wrapper tobacco grown in the Connecticut Valley has been seriously damaged due to ozone injury. Injury has been reported on 36 different commercial crops. Crop damage has been found in every State with large industrial centers.

Sediment, the product of soil erosion, is a major pollutant and does serious damage to farmers and rural people. Conservative estimates indicate that sediment damages in the upstream watersheds alone come to about $85 million annually. Sediment fills stream channels flowing through farms and ranches. It fills irrigation canals, farm ponds, and rural reservoirs used for recreation, fishing, irrigation, and farmstead water use.

The thousands of farmers using farm ponds to sell fishing rights are much concerned with the deterioration of water quality by sediment delivery.

Every 1,000 tons of sediment eroded from our fields robs the land of 25,000 pounds of plant nutrients.

There are about 40 million acres of irrigated land in the United States, most of which is in the 17 Western States. Income from nearly a quarter of this acreage is impaired by an accumulation of salt brought in by irrigation water or collected by natural processes.

Historically, farmers have depended on manure as a prime source of soil fertility. During the past two decades tremendous progress has been made in the technical efficiency of fertilizer manufacturing. Nitrogen fertilizer is cheaper now than it was during the depression of the thirties. Consequently, numerous economic studies have shown that it is cheaper for a farmer to fertilize his fields from the fertilizer bag than to haul manure from the barnyard. But this still leaves the livestock farmer with a large mass of matter to dispose of—manure that he usually can't sell, can't give away, and can't burn. With the tight cost-price squeeze that crowds most farmers, relatively little investment can enter into manure handling.

The stuff we are talking about has a characteristic aroma that many find objectionable. Thus, when suburbanites move into farming areas they often object to certain facets of country atmosphere. Frequently, the new suburbanites get a restraining order from the courts to the effect the farmer has to quit his livestock operation or make a very costly move to another location further from suburbia.

The problem of effectively handling and disposing of manure is causing a serious financial burden on many of our farmers, poultrymen, and feedlot operators.

Plant and animal disease agents carried by the environment have caused tremendous losses in agriculture and forestry.

In the 50 years or so since chestnut blight was first discovered in this country, this disease has practically killed all of the American chestnuts, one of our finest hardwoods, in millions of acres of its native range.

In the epidemic year of 1935, stem rust caused a 60-percent loss to the wheat crop in Minnesota and some of the neighboring States, and the loss to the country as a whole was almost a quarter of the crop. Stem rust is a continuing threat to world food production.

Hog cholera was first noted in this country in the 1880's, but it spread rapidly. The virus causing the disease may be picked up from polluted water, polluted soil, or polluted feed. Over the years, the ravages of this disease have caused losses of hundreds of millions of dollars to hog farmers.

Mr. Chairman, these few examples will indicate that agriculture and forestry are indeed severely hurt by environmental pollution. It is an important part of the mission of the USDA to help in meeting these problems.

WASTES FROM AGRICULTURE AND FORESTRY (AIR POLLUTION)

Although most air pollution arises from industrial and metropolitan areas, forest fires and the burning of field residues make a contribution.

We must face the fact that forest fires are a major concern in the United States. During a typical year, there are about 150,000 forest fires in this country, which ravage 5 to 7 million acres. In addition to heavy monetary losses from destruction of timber resources, wild forest fires in the average year produce an estimated 160 cubic miles of smoke in the convection column. Such fires generate about 34 million tons of particulate matter each year, largely as carbon and ash; and about 338,000 tons of hydrocarbons are vaporized and condensed.

Mr. Chairman, our Forest Service is doing everything possible to find ways to cut down on air pollution from wild forest fires.

In some of our Western States the burning of residues in rice fields, wheat fields, and grass-seed lands may produce local air pollution problems.

Thirty million tons of natural dusts are emitted into the atmosphere each year. Although agricultural lands are not the sole contributor of these dusts, windblown soil is a major factor. Although much progress has been made in getting needed conservation practices on the land to prevent the tremendous clouds common during the Dust Bowl days of the thirties, our conservation task is a long way from completely tying down soils susceptible to wind erosion.

SEDIMENTATION

Committee Print No. 9 of the Senate Select Committee on National Water Resource states that:

> **Rough estimates of the suspended solids loadings reaching the Nation's streams from surface runoff shows these to be at least 700 times the loadings caused by sewage discharge.**

Curbing sediment delivery to our streams and lakes by aiding farmers and ranchers to minimize soil erosion has long been a key objective of the Department of Agriculture. In the thirties sediment delivery on the Piedmont Plateau of the Atlantic Coastal Plain and the Black Belt of Alabama was enormous. One sees far less erosion on the soils of these regions now due to the establishment of sound systems of conservation farming; the farms have largely been converted from continuous row crops to continuous meadow.

But we are not achieving the same results in some other parts of the country in curbing soil erosion and sediment delivery. The advent of highly mechanized farming using six- to eight-row equipment militates against the installation of terraces or other land protection measures that would interfere with planting, tilling, and harvesting equipment. The tight cost-price squeeze on the farmer leaves him little financial leeway to worry about sediment problems 100 miles downstream. Conservation farming adjusted to the needs of highly mechanized operations is urgently essential in many parts of the country.

Forest burns poses a serious problem in sediment delivery. With loss of protective cover, soil erosion on such areas may become intense.

CHEMICAL FERTILIZERS

We Americans apply 32 million tons of chemical fertilizers on our lawns, gardens, fields, and pastures. Some folks think this is a tremendous tonnage of chemicals that may be contaminating our soils, our streams, and ground waters by runoff and deep percolation.

The average use of chemical fertilizers per cropped acre in the United States is only one-tenth the level used in the Netherlands. Even so, fertilizer use in the United States over the past 50 years has doubled about every 10 years.

Since nitrogen and phosphorus are the nutrients of primary concern that enable growth of "algal blooms" on ponds, lakes, and streams, naturally, a suspicious eye is sometimes cast at Agriculture's widespread use of these chemicals.

Some nitrogen is moving from fertilized fields with land runoff, but most of our evidence indicates this is a minor contributor to stream nitrogen at the present time.

Mr. DADDARIO. On that point, Mr. Grant, Dr. Commoner at the New York AAAS meeting said he thought that nitrates from ground water were a danger. They have appeared in milk, drinking water, and food. Now, this runs somewhat contrary to what you have just said, that it is a minor contributor. If this is so, what should we do about it and how do you feel about Dr. Commoner's remarks in that regard?

Mr. GRANT. May I ask Dr. Wadleigh to respond to this since this is in his particular area.

Dr. WADLEIGH. Dr. Commoner especially emphasized the nitrate content of spinach as a baby food. Samples have been found carrying up to 3,000 or 4,000 parts per million of nitrate. I happened to look up some data in a 1907 issue of the Journal of the American Chemical Society the other day wherein analyses of spinach and many other foods for nitrate were made. In 1907, the spinach samples collected were found to contain from 3.000 to 4,000 parts per million of nitrate. Last year a group of chemists published data on similar samples of spinach from local markets. The samples contained from 250 to 800 parts per million of nitrate. The increase in use of nitrogen fertilizer on the land over this 60-year time has not been reflected in an increase nitrate content of vegetables.

One also has to recognize that nitrate accumulates in soils as a natural process. Back at the turn of the century, in 1910 and 1911, chemists at Colorado State University were posing this problem: Why does nitrate accumulate naturally in the rangelands at such high level? These are the nitre spots of eastern Colorado soils.

At the meetings of the American Association for Advancement of Science a year ago, Dr. Stout of the University of California presented his studies on nitrate in well water. Some well waters run from 10 to 130 parts per million of nitrate. They have been used for drinking water but no adverse effects have been noted. These waters might have adverse effects if given to ruminant animals. The bacterial population in the rumen readily reduces the nitrate to nitrate and it is the nitrite that is poisonous.

There are instances, of course, wherein "blue babies" have been associated with nitrate in well water. Recent evidence indicates that this effect of nitrate does not take place unless there is also bacteriological polluion in the well water. The bulletin provided by the Public Health Service on drinking water quality standards cites many, many cases of "blue babies" afflicted from drinking well water containing nitrate. They have never found a "blue baby" case associated with drinking surface water containing nitrate. This indicates that bacteriologic pollution entering the baby's stomach with water induces the reduction of the nitrate to poisonous nitrite causing methemoglobinemia.

Mr. Daddario. That is very interesting, Doctor. I just wonder if there is this accumulation in this way that you indicate to be natural.

Dr. Wadleigh. Yes.

Mr. Daddario. Isn't it incumbent on us, then, to see if we can develop a nitrate fertilizer which we could contain and prevent from being as mobile as it is, and, therefore, not adding to what must be becoming a natural problem.

Dr. Wadleigh. I think there is an urgent need to develop better fertilization technology since nitrate is so exceedingly soluble. Studies by my staff members indicate that as much as 40 percent of the nitrogen fertilizers applied to the land each year do not enter into beneficial use to the crops. The farmers are spending $1.5 billion per year for chemical fertilizers. They are applying over 6 million tons of elemental nitrogen. What happens to this 40 percent of the nitrogen fertilizer that does not enter into beneficial use? A small amount goes into land runoff. Some goes into deep percolation. These are minor. Much of our evidence indicates that much nitrogen is lost by chemical reaction in the soil and returned to the atmosphere as gaseous nitrogen. Much nitrogen is sometimes absorbed at excess levels into crop plants.

There have been quite a number of instances in the Middle West, Indiana, Illinois, and Missouri, of cases called "silo disease." When corn or any other forage high in nitrate goes into the silo and starts fermenting, the nitrogen oxides are given off. Silo workers can become very ill. A few have been killed. When high nitrate forage is fed to ruminant animals, they can become very sick. This is sometimes a serious problem when highly nitrogenous forage is used.

As we use higher and higher levels of nitrogen applications on our fields, chemical forms that would not be readily converted to nitrate would be advantageous. The nitrate step is averted. Plants may use nitrogen as ammonium. For example, a sugar beet plant does not grow effectively unless there are 5,000 parts per million of nitrate in its petiole. Ammonium nutrition could avert this buildup.

If this sugar beet foliage high in nitrate is used for cattle feed, they are in danger of nitrite poisoning.

We in agriculture feel there is a great opportunity to develop technology of providing crop plants with ammoniacal urea, or other forms of nitrogen so that the nitrogen does not go through the nitrate stage.

Mr. DADDARIO. Everything that you say is somewhat frightening because we are beginning to develop nitrogen fertilizer plants all over the world with tremendous capacities. Mr. George Woods, President of the World Bank, before our committee, cited as a particular example our ability to meet some of the food problems in India and other places. There is now developing a capability where we expect to get production to quadruple or even be better than that.

Dr. WADLEIGH. Correct.

Mr. DADDARIO. So we will be using the same kind of fertilizer in an ever increasing amount despite the dangers which might accumulate, as you have spelled them out here today, Doctor.

Dr. WADLEIGH. I think there is a lot that could be done to improve the situation.

Mr. DADDARIO. Tell us about that. What do you think ought to be done?

Dr. WADLEIGH. The main effort needed is a concentrated study into the efficiency of the use of fertilizer by different crops. There has not been any pressure for increased efficiency of use because nitrogen fertilizer is so cheap. It is much cheaper now than it was back in the twenties. I grew up on a farm in Massachusetts.

Mr. DADDARIO. I could tell you came from Massachusetts.

Mr. GRANT. Since I came from New Hampshire, we really are quite close together.

Mr. DADDARIO. Where was your farm?

Dr. WADLEIGH. Southbridge. Nitrogen would cost 20 or 25 cents a pound when we were buying sodium nitrate back in the twenties. Now farmers are able to apply it on for 8 cents or 9 cents a pound. It is the cheapest commodity they can buy for improving their yields. We need to know more about the forms that we can put into the soil, where it should be placed in the soil, and at what time in the physiological growth of the plant so that it produces the maximum yield, and yet have the soil nearly exhausted of nitrate by harvest time.

The difficulty in many areas is that the nitrate accumulates and it is in the soil at the end of the harvest. Those who are acquainted with the sugar beet industry of the Western States know processors are deeply concerned with the deterioration of the quality of beets associated with nitrogen accumulation at the end of the season. We need far better information of the forms of nitrogen fertilizer to use that will not be readily leached out; where exactly this should be placed in the soil to provide maximum benefit to the plants: the time in the physiological growth of the crop when nitrogen availibility would be most beneficial; and the development of varieties of plants which have high efficiency in using available nitrogen.

Some of you may be acquainted with the large sugarcane industry on the muck soils of Florida. When conventional sugarcane varieties were cultivated on that muck, they would not produce commercial crops of sugar. There was too much nitrogen in the soil. It runs nearly

4-percent nitrogen. Varieties of sugarcane had to be developed that had very low efficiency in using this excess nitrogen so as to enable sugar to accumulate.

This is part of the natural growth processes. If the plant is using too much nitrogen, it will not accumulate sugar or carbohydrates. This may be why there is some complaint about the poor quality of New England potatoes at the present time. Too much nitrogen?

We can develop varieties of plants that have much higher efficiency in the use of the nitrogen. As a matter of fact, this is what has been done in the last few years by the Rice Institute in the Philippine Islands. They developed varieties of rice with a very short stalk which will not fall over when given high levels of nitrogen. The varieties are not responsive to day length, so they will produce crops every 90 days regardless of time of year; and they will respond to and use very high levels of nitrogen application. As a consequence, the Rice Institute of the Philippines has been producing 200 bushels of rice per acre every 90 days on their experimental fields.

India's average yield of rice per acre is now about 25 bushels per acre. Think what it means in terms of world food needs to develop rice varieties that have high efficiency in the use of available nitrogen together with the tremendous potential for high yields.

Mr. DADDARIO. That is very interesting. I am always amazed that you people can do these things.

Dr. WADLEIGH. Thank you.

Mr. DADDARIO. We are very proud, in New England, that we do have people who have an interest in this. Some of our great seed and food crops have originated through research done in New England. We sometimes take a little more credit in Connecticut than we should, but we keep it in the New England area.

Mr. Grant, will you continue, please.

ANIMAL WASTES

Mr. GRANT. Domestic livestock produces wastes. For example, the 125 million cattle on our farms and ranches produce over a billion tons of solid wastes and over 400 million tons of liquid wastes. About half of these wastes are produced in concentrated supplies such as in barns, barnyards, and feedlots. Offensive odors may arise from these wastes. Piles of manure may become breeding grounds for flies and other pests. This manure may be a carrier for infectious agents. If it drains into streams, it may deplete the oxygen by its biochemical oxygen demand.

A large cattle operation such as a feedlot carrying 20,000 head must dispose of 550 tons of manure a day.

Mr. DADDARIO. What are we going to do about it?

Mr. GRANT. This is a problem which is related to many of the things that are being done in the Department. We feel that the relationship between this problem and the land use practices which we are putting on farms to curb erosion and reduce the amount of runoff that gets into streams is a part of the problem. There are many other possibilities which, again, I would say Dr. Wadleigh has investigated very carefully and I am sure he would be in a much better position to indicate the extent of involvement of the Department in this important area.

Mr. DADDARIO. I know you cannot give us the solution to the problem in the time available, but will you give us an idea?

Dr. WADLEIGH. We have explored the effectiveness of putting these wastes into oxidation lagoons, but lagoons must have a tremendous capacity to serve a large feedlot. We must explore ways of economically putting manure back onto the land.

In the past, we have emphasized the idea that it is cheaper to get the nitrogen out of the fertilizer bag than to put it on the land. However, I think that the land is still the place for the disposal of manure. It can provide some benefit and may be the cheapest disposal.

We have any number of experiments over the United States where manure added to the soil produces benefits above any chemical addition that one can provide. In areas where it might not be feasible to put the manure in the land, then the lagoon system may have to be used. I feel there must be developed more efficient mechanized systems of getting this stuff back into the land; and incorporated so it does not smell, and does not occur in the runoff into our streams and reservoirs.

MEETING PROBLEMS OF ENVIRONMENTAL QUALITY

Agriculture and forestry have a long history of developing technolgy and providing technical guidance and other forms of assistance toward improving the quality of our environment.

AIR POLLUTION CONTROL

We have mentioned our concern with air pollution. The U.S. Forest Service is carefully studying the resistance on susceptibility of pine seedlings to airborne chemicals. They have made selections of ponderosa and eastern white pine that are nearly immune or highly tolerant to specific air pollutants such as sulfur dioxide, fluorine, ozone, and photochemical smog. These selections will be especially valuable for plantings in and around industrial and metropolitan areas.

We are continually developing improved varieties of cigar-wrapper tobacco that may be grown in the Connecticut Valley without significant damage from air-pollution fleck on the leaves.

The U.S. Forest Service began developing improved techniques for forest fire control in 1923. This technology has been applied with remarkable effectiveness toward reducing air pollution arising from burns in our Nation's forests. This is indicated by the fact that fire damage in the national forests has been reduced over a 40-year span from 602,000 acres in 1924 to 92,000 acres in 1963. At the average damage of $76.45 for each acre burned, the cumulative effect of developing and using improved forest fire control technology over the past 40 years comes to $39 million a year.

EROSION CONTROL

Conservation practices on the land have contributed importantly in reducing the threat of future "dust bowls" in the Great Plains. One of the best testimonials to this point was the experience of farmers in Kansas during the drought of the mid-1950's, which records show was just as bad as that of the 1930's. Soil blowing was not nearly as serious as it was 20 or 25 years earlier. At Dodge City, Kans., in 1936–37 there were 120 days of blowing dust. At the same location under comparable conditions in 1956–57 there were only 40 days of blowing dust.

Studies started by the Department of Agriculture back in the twenties showed that graded cropland terraces can reduce soil erosion and sediment delivery; and in combination with such practices as crop rotations, mulching, minimum tillage can reduce soil loss from cultivated fields to practically nothing. Converting croplands to good grasslands, pasture, or woodlands can nearly eliminate sediment delivery.

The Department of Agriculture has had a major impact on the conservation and protection of soil and water resources and the preservation and enhancement of natural beauty through its vigorous programs of research, technical help, land management, credit, and cost-sharing assistance. USDA has provided help in contour farming on 43,900,000 acres, in 29,000 miles of hedgerow and 82,000 miles of windbreak planting, in building 1,600,000 acres of grassed waterways, in planting trees on 13 million acres, in preservation and development of 18 million acres of wetland and wildlife habitat. In fiscal year 1967, fire protection was provided on 210 million acres of forest. Farmers Home Administration loans and grants of $200 million for construction of rural community water and waste disposal systems, $28 million for development of rural recreation areas, and $442 million for construction and repairs of homes and farm buildings were made. These measures aid soil stabilization, water conservation, control of runoff, and pollution control; they also improve the attractiveness of the landscape.

FERTILIZER RESEARCH

The Department of Agriculture has been studying the behavior of phosphorus in soils, water and plants for 80 years. We know there are only traces of phosphate actually in true solution in the soil. Phosphate is held on the surface of clay particles by high energies of retention. We have studied its chemical behavior extensively by using radioactive phosphorus as a tracer. We know that only minute amounts of phosphate move from our fields in runoff water except by their attachment to eroding soil. Soil conservation measures obviously, therefore, are the first measure of defense against pollution.

Nitrogen is another matter. That which is present as nitrate is highly soluble and will readily move with water if not absorbed by plant roots. Studies in Colorado at the turn of the century show that it is part of natural processes for nitrate to accumulate in some soils. We know that more nitrate may leach out of unfertilized, uncropped soils than from those well fertilized and growing a crop. Roots are avid absorbers of nitrate.

We have developed and provided information on proper fertilizer placement, timing of application, and optimal levels of needed applications for the different agricultural soils of the United States to help the farmer gain maximum beneficial use of his purchased fertilizer, while minimizing losses to the environment.

HANDLING OF ANIMAL WASTES

Improved efficiency in manure handling systems are being developed by agricultural engineers. These involve using disposal lagoons, lagoons with artificial stirring to improve oxidation, conversion to slurry with land application through an irrigation system, development of a plow-furrow-cover technique, as well as improved ways of following the tried and true practice of spreading manure on the land under conditions that would minimize contamination of runoff water.

Our extensive program of veterinary research inspection and regulation have brought transmissable diseases in this country to a remarkably low level. Bovine tuberculosis and hog cholera have nearly been eliminated in this country. We are free of foot-and-mouth disease of our animals, disease which is even now ravaging the cattle of England and many other parts of the world.

THE JOB AHEAD

There is still much to be done in curtailing environmental pollution related to agriculture and forestry. In meeting this task, it is mandatory that there be a minimum of unnecessary and misdirected effort.

It would be folly of the first magnitude to think that handling manure in the barnyard and coping with runoff carrying plant nutrients and sediment could be adequately dealt with as distinct and separate problems.

These problems are best solved at their source on the land.

Agriculture in the United States today is a highly mechanized operation, operating under the pressures of complex cost-price relationships. Any technology that is developed and put to use on the land must fit into a highly integrated management system, using a minimum of labor while producing economic yields of high-quality crops of food and fiber. Environmental pollution controls must be developed in such a manner that full consideration of the impact on agricultural enterprises are fully recognized.

In developing technology with respect to environmental pollutants on the land, we must recognize that air and water are the two main transport vehicles. For example, we must be helpful to land managers and developers in preparing plans that will take into account the characteristics of their soils and topography, climate, and the kinds of enterprises that are profitable in their area.

There are many instances where costly mistakes have been made by suburban developers, industrial companies, and even large farming and forestry operations by their going ahead without having adequate information about such things as the kinds of soils prevailing in the specific area. Soils vary tremendously in the way they take water; in the way they erode under overland flow; the way they shrink and swell, depending on moisture content; their bearing strength under loads; and their susceptibility to deterioration in tilth and tractability.

Maintaining a wholesome environment calls for an entire package of practices and a special competence in relating them to one another and to the needs of the environment. This package includes those practices that will assure this country a continuing abundance of good food and fiber at low cost. At the same time, we must keep in mind the urgency of preserving and enhancing natural beauty and of protecting health and safety of people by maintaining the quality of water, air, and soil.

This Department recognizes that we still have a big job to do. But we are committed wholly to this as a principal need of this era, and are gearing up our programs to be of maximum helpfulness in applying the improved technology needed to upgrade and maintain the quality of our environment.

Mr. Chairman, I would like to offer for the record "Resources in Action, Agriculture/2000." In this document, this Department has set in sharp outline the steps it proposes to take to assist man to live in harmony with his natural environment.

(Document referred to can be found in committee files.)

Mr. Daddario. Thank you, gentlemen.

I regret we do not have more time to go into certain parts of your statement. I am particularly concerned with how you relate your activities with the other agencies, what the mechanisms are, how you divide the work, and what is the relationship of overall governmental responsibilities in developing a proper pollution control program in the most efficient way possible. We will have to develop that for the record, I would suspect.

Mr. Grant. We shall be happy to provide the information.

(The information requested is as follows)

There are several mechanisms enabling the coordination of activities in the Department of Agriculture with comparable endeavors in other executive departments. First of all, the Water Resources Council is an excellent medium for coordination of work pertaining to some aspects of water pollution. The membership of this Council is made up of the Secretaries of Agriculture; Defense; Health, Education, and Welfare; and Interior; and the Chairman and Commissioners of the Federal Power Commission. The Sedimentation Committee set up under the Council meets regularly and offers a good mechanism for interagency communication on matters pertaining to water pollution from sediment. In 1963, this Committee sponsored an interagency symposium providing for presentation and discussion of all work on sedimentation by all agencies involved. The 900-page document covering the symposium was published as U.S.D.A. Miscellaneous Publication 970.

Regularity of water flow in streams and the avoidance of low flows are also related to degree of pollution in surface waters. The Committee on Hydrology under the Water Resources Council provides a focal point for communication and integration of work related to stream flows.

In 1962, the Federal Council of Science and Technology set up a task force to look into all aspects of water resources research, including coordination and joint planning. The effort included studies on water quality as affected by pollution. The work of this task force was published under the title of "Report to the President on Water Resources Research" as a Committee Print of the Senate Committee on Interior and Insular Affairs, 88th Congress, 1st Session, February 11, 1963. This report recommended that a Committee on Water Resources Research be set up under the Federal Council for Science and Technology. Such a committee was established under FCST in September 1963. Among the assignments to the committee was to develop an integrated Federal Water Research Program that provided for inteagency communication and coordination.

One of the reports of the FCST Committee on Water Resources Research entitled, "A Ten-year Program of Federal Water Resources Research," was published in February 1966 and provides on pages 53–58 a terse statement on "Water Quality Management and Protection in Relation to Pollution."

Over the past two years the Committee on Water Resources Research has maintained a very active subcommittee on problems of water quality in relation to pollution. This subcommittee not only provides for coordination but is developing more realistic recommendations for an integrated Federal program on problems related to water pollution.

During the summer of 1967, the Federal Council of Science and Technology established a Committee on Environmental Quality. It appears certain that this new Committee will move forward in its work of coordination with the same effectiveness as observed for the Committee on Water Resources Research.

The Interdepartmental Federal Committee on Pest Control made up of representation from the Departments of Agriculture, HEW, Defense, and Interior meets monthly and provides means for communication and coordination on problems related to environmental pollution form pesticides. Furthermore, scientists concerned with problems of pest control in the Agricultural Research Service meet annually with their counterparts in the Public Health Service, the Department of Defense, and the Tennessee Valley Authority in order to provide for communication and coordination of research programs.

Research on air pollution problems conducted by the Agricultural Research Service and the Forest Service are carried out under very close cooperation and consultation with those responsible for air pollution investigations in the Department of Health, Education, and Welfare. In fact, an appreciable portion of the research in the Department of Agriculture on air pollution is supported by funds transferred from Health, Education, and Welfare.

The Department of Agriculture has many different mechanisms of developing priorities in research. Under legal authority set up under the Research and Marketing Act of 1946, the Department appoints a number of research advisory committees that are composed of people outside the Department of Agriculture. The committees are made up of scientists and lay people familiar with the problems. These committees have met annually and submitted to the Secretary of Agriculture reports in which they have evaluated ongoing research, indicated priorities, and pointed out problems needing additional attention. Three such reports having relation to environmental quality are submitted for illustrative purposes.

The Department is especially responsive to the recommendations of high level committees such as the President's Science Advisory Committee (PSAC) and pertinent ones appointed by the National Academy of Sciences—National Research Council (NAS–NRC), and the Public Advisory Committee on Soil and Water Conservation to the U.S. Department of Agriculture. The PSAC Reports on "Use of Pesticides" (1963) and "Restoring the Quality of our Environment" (1965) were especially useful as were the NAS–NRC reports on "Scientific Aspects of Pest Control" (1966) and "Waste Management and Control" (1966).

In October 1966 the Department of Agriculture completed a two-year study that involved the thinking of some 400 scientists both within the Federal Government and at the State Agricultural Experiment Stations under the title of "A National Program of Research for Agriculture." The Department of Agriculture feels that this study is monumental as a way for developing an integrated research program that is regional in scope. A copy of this report is submitted herewith.

Key researchers who are intimately involved in solving problems are frequently in an advantageous position to weigh and decide what research most urgently needs to be done. The Department of Agriculture gives important considerations to the recommendations arising from in-house work planning conferences involving its leading researchers.

Mr. DADDARIO. I have one question, which we may not be able to finish. When Dr. Buckley was here, he touched on the fact there were $75 million being spent at the present time on research related to environment.

Recognizing the interest there is in herbicides and pesticides and their long-term effect on ecology, what is the Department of Agriculture doing in this field, and what kind of risks are involved in it?

Dr. WADLEIGH. There is no question that the Department is just as much concerned with persistent pesticides, such as the chlorinated hydrocarbons, as any group of individuals you can find. The great emphasis on our pest control program is to find alternate means of control. The use of radioactive energy to sterilize the male screw-worm flies, which eliminated the populations of this insect in almost all parts of the country, was an outstanding example. It has saved the cattle industry millions and millions of dollars. The development of sex attractants so the insects move to this odor and, while moving to it, they go through a device that electrocutes them is another example of alternate means of control. There are many alternate ways that are being developed.

Then we must develop—and we are working on this—pesticides that are nonpersistent and ones that are more specific to the insect that one wishes to control.

Mr. DADDARIO. That creates a problem right away in the market.

Dr. WADLEIGH. Yes. After all, I am sure that agriculture suffers seriously from these nonspecific pesticides. Think of the billions of honey bees that have been killed, insects that pollinate our plants. Think of the billions of beneficial insects that have been killed by these pesticides.

In California in the citrus industry, predators control quite a number of insects, but a nonspecific pesticide also kills the predator.

Mr. DADDARIO. It is too bad we did not think this way when we were first beginning to work on these control measures.

Dr. WADLEIGH. Hindsight is so much better than foresight.

Mr. DADDARIO. I think it does enhance our vision. The discussion we had in the earlier part of the day revolved on the fact that we should have professional people competent not only to develop the work but to take the great responsibility of calling attention to the ill side effects as well as the positive gains. This is not necessarily a hindsight situation. We need to develop a forecast capability so we might be able to make assessments of those programs that are important to us, to see if they will, in fact, do everything they are touted to do, and to come to some better judgment in the future. I do not think we have too much room to move around in. Lessons we can learn from the past ought to be assessed in a complete way, not that it will just kill off insect A, but how it affects our whole environment.

Dr. WADLEIGH. That is very true.

Mr. DADDARIO. I say that only because I think, Dr. Wadleigh, we we have a tendency to use the umbrella of hindsight. Actually, it is an easy way to get out of our inability from the research, science, and technology point of view to make an assessment is part of the research job. The job of looking ahead and not looking back.

Dr. WADLEIGH. You are so right.

Mr. GRANT. I think the maximum effort to do this is certainly incumbent upon anyone who is working in this field. I know we recognize this responsibility, and it weighs heavily upon us.

However, as you have pointed out, this has not always been the case. Many assessments have not been completely accurate as to future implications.

Mr. DADDARIO. In this committee we have a bill on technology assessment. I wish we could develop a national characteristic that would be part of our research effort to look at things in the whole way.

You spelled out a very interesting and frightening proposition, Dr. Wadleigh. The fact is, it does not make much sense to kill off everything to get at one. I recognize there are great economic problems, some of which you have already on, which show how it is false economy to approach it that way. The long way around and the more expensive way in the final analysis might be cheaper.

Talking about environment, plants and animals, and our place in it, it might be a lot cheaper if we did the complete job in the first instance, recognizing that it is difficult.

Mr. **Grant**. Assessing the damage, of course, has to go along with a correct assessment of the benefits.

Not to prolong this, there are many things which you have so correctly pointed out that need to be considered. There is an economic analysis which must be made in terms of the urgency of the problem and the need for solution, but also, proper consideration of the effects must be considered on a long-term basis as well.

Mr. **Daddario**. We could philosophize for the rest of the afternoon, I suspect, but we do not have time. We will be in touch with both of you. The committee appreciates your coming. We regret we had to sandwich you into what we knew already would be a full day. We have your statement in the record, and we will have a chance to follow through from there.

Mr. **Grant**. Thank you very much.

Mr. **Daddario**. The committee is adjourned until tomorrow morning at 10 o'clock, at the same place.

(The subcommittee adjourned at 12:35 p.m., to reconvene at 10 a.m., Friday, February 2, 1968.)

ENVIRONMENTAL QUALITY

FRIDAY, FEBRUARY 2, 1968

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

Environmental quality has assumed a third dimension in addition to air and water pollution. It is the problem of solid wastes.

We realize that the gases and liquid effluents of society go directly into the air and water environments. But solid wastes are actually the precursors of pollution—if they are not managed properly. Packaging, castoff appliances, demolition debris and the like are testimony to the fact that we do not have a recycle economy but live in an era of planned obsolescence and the throwaway container.

The key to a great deal of pollution will lie in our ability to eliminate as much waste as possible and to deal ingeniously with the material which we must dispose of. Title II of the Clean Air Act of 1965 shows the intent of Congress to provide Federal leadership in solid waste disposal. Scientific and engineering activity is an important part of the authorized program. It is our hope that during these hearings we will be able to come to some judgment as to how management is going about the handling of all of this.

Our witnesses today are Mr. Richard Vaughan, director of the solid wastes program of the Public Health Service, Mr. Arsen Darnay of Midwest Research Institute, and Dr. Walter Hibbard of the Bureau of Mines. We will begin with Mr. Vaughan.

Proceed please.

(Mr. Vaughan's biography follows:)

RICHARD D. VAUGHAN

Chief, Solid Wastes Program, National Center for Urban and Industrial Health is a Commissioned Officer of the Public Health Service presently stationed in Cincinnati, Ohio. He was born in Evanston, Illinois. He is married and has three children.

Education

Bachelor of Science in Civil Engineering—Georgia Institute of Technology—1951

Master of Science in Engineering—University of Michigan—1961

Master's Degree in Public Health—University of Michigan—1962

Associations and honorary groups

American Public Works Association
American Public Health Association
Phi Kappa Phi, Delta Omega and Chi Epsilon

Mr. Vaughan has been awarded the Public Health Service Commendation Medal and he received the William Gibson Memorial Award for scholastic achievement in environmental health while studying at the University of Michigan.

Previous experience

A Commissioned Officer of the Public Health Service since graduation from college with assignments in Georgia, Texas, Oklahoma, Michigan, Washington, D.C. and Cincinnati, Ohio. Served in several areas with the Communicable Disease Center as a training officer in environmental sanitation; Deputy Project Director of the Arkansas-Red River Water Quality Study; Project Director Detroit River Lake Erie Water Pollution Control Enforcement Project; Director. Robert S. Kerr Water Research Center in Ada, Oklahoma; Chief, Environmental Sanitation Program, National Center for Urban and Industrial Health; and currently Chief, Solid Wastes Program, National Center for Urban and Industrial Health.

STATEMENT OF RICHARD VAUGHAN, DIRECTOR, SOLID WASTE DIVISION, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Mr. VAUGHAN. For the record my name is Richard Vaughan, and I am chief of the solid waste program in The National Center for Urban and Industrial Health of the Public Health Service, Department of Health, Education, and Welfare.

Mr. Chairman, I am pleased to be here today and welcome this opportunity to present a report on the adequacy of technology in the field of solid waste management and what the solid wastes program of the Public Health Service is doing to close existing gaps in this technology.

I would like to submit my entire statement for the record and discuss some of its major points.

Mr. DADDARIO. If you would, please.

Mr. VAUGHAN. Thank you.

The solid wastes program was established to carry out the directives of the Solid Wastes Disposal Act of 1965.

In enacting this legislation, Congress recognized the increasing problems of solid waste management which have been accentuated by continuing technological progress and improvement. The Congress also recognized the fact that inefficient and improper methods of solid waste disposal threaten the health and well-being of the Nation. including interference with community life and development. Following the directives in this act, the Public Health Service has established an organizational entity to address itself to these problems and find solutions for today and tomorrow and thus, assure adequate protection of the air, land, and water resources of this country from degradation through inadequate and improper management of solid waste.

Now, I would like to discuss what the Public Health Service has done to better understand the adequacy of solid wastes practices and problems in this country and develop effective technology to cope with these problems.

The improved technology we seek must satisfy other requirements in addition to being scientifically sound. These innovations must also be economically feasible for our society and must be safe from the standpoint of public health and the protection of our precious natural resources—our land, air, and water.

Technological development alone—no matter how effective, how economical, or how safe—will not do the job that is needed to be done to improve solid waste management in this country. Once new solutions are found and proven effective by research and development, their practicability and applicability to a real situation must be demonstrated. The public's attitude toward solid waste management must be changed to allow acceptance of new concepts. Communities which are jurisdictionally autonomous but collectively make up regional or metropolitan areas, must learn to cooperate and work together for the adoption and implementation of solid waste collection and disposal techniques which economically and effectively serve the best interests of all. No matter how innovative new technology is, the facilities involved must be operated properly to achieve the benefit intended by the developer. This then is the complete job of solid waste management—the approach to which the solid wastes program of the Public Health Service is dedicated.

Mr. **Daddario**. Mr. Vaughan, would you go into the way in which you expect the public to participate? You touch on the importance of the public understanding all of this. How do you get them to understand? What do you mean by that? How do you intend to go about it?

Mr. **Vaughan**. When I mentioned public attitude must be changed, the question might be how do you change this attitude, in what respects should it be changed.

Mr. **Daddario**. I am not assuming it is good, bad, or indifferent. What made you come to that determination of what is good and bad, and where do you go?

Mr. **Vaughan**. We find many people are not willing to accept solid waste management as a part of their community function. They want their solid waste taken off. They don't want it anywhere nearby.

We also find people putting this at the low end of the totem pole. They are willing to do almost anything except spend money for improving solid waste practices.

Another thing. Cities may be part of a metropolitan complex with 10 or 15 other communities, none of which has the real financial ability to handle this alone, but they have a reluctance to work together. I don't understand sometimes why they have this reluctance, but they do.

I assume it might be that they do not desire to give up their autonomy; but somehow, for their own good or the benefit of their citizens, ways must be found to preserve their integrity and still allow them to work together for better solutions. In these areas public attitudes must be changed.

Mr. **Daddario**. How?

Mr. **Vaughan**. We are doing it by demonstrating to them good technology. This is one of the purposes of the demonstration grant technique.

Mr. **Daddario**. Don't you need to have some kind of research into why it is this way and how it can be changed?

Mr. VAUGHAN. We have a contract proposal now that tends to go into psychometric research on why people do things. Hopefully we will get some insight into this.

Mr. DADDARIO. Who is doing this?

Mr. VAUGHAN. It is being negotiated now, being discussed. I don't know who is going to get it.

Mr. DADDARIO. Tell me what it is comprised of.

Mr. VAUGHAN. It is comprised mainly of trying to assess the reasons why people do things in general, why people are reluctant to improve solid waste disposal practices, what things should we do to get this changed, whether it be research, demonstration, or whatever.

Mr. DADDARIO. You say that you have a proposal out. To whom are you appealing? Who do you expect will be the people who will perform the contracts? Are they university people?

Mr. VAUGHAN. No. They would probably be nonprofit or profit research organizations, such as Booz-Allen, Aero Jet General, or someone of this nature. They are not necessarily going to get it, but someone who specializes in this type of work. Probably not a university. Management specialists.

Mr. DADDARIO. You say it is a management rather than a social science problem?

Mr. VAUGHAN. I see it as both, management for us to do something effectively to cope with this, and social science in finding out what motivates people.

Mr. DADDARIO. Would a management firm such as Booz-Allen and the ones that you listed, have a social science research capability?

Mr. VAUGHAN. I don't know. The ones who bid on this are required to.

Mr. DADDARIO. That is one of your specifications?

Mr. VAUGHAN. Yes, sir; on this particular contract.

Mr. DADDARIO. What made you come to the determination that you needed to have this study?

Mr. VAUGHAN. Several examples. When we got involved in the solid wastes program activities, when we saw cities that would not take the steps to improve disposal practices—that to us made no sense. Why they would permit an open burning dump to just go on smoking, why they wouldn't allow sanitary landfills to be established when we have seen many satisfactory operations. There is one not too far from here, incidentally.

When the citizens of one State refused to allow, because perhaps of a prejudgment of what it would be, sanitary landfill to be placed in their community, to eliminate a dump.

Mr. DADDARIO. I wonder, is that a social science problem or is it a regulatory problem? Does it not go into the relationship of the State to the Federal Government? Which should predominate under these conditions?

Mr. VAUGHAN. I don't know how I could classify it precisely under one problem or another. I do know it is keeping the Nation from getting the kind of solid waste practices it should have, this attitude.

Mr. DADDARIO. I would offhand classify that kind of a problem as just one where the solution is obvious. It just becomes a question of how you put into effect the necessary regulations and recognizing the inhibitions which exist in allowing the Federal Government to force action. You could stop that kind of activity without any kind of study at all, could you not?

Mr. VAUGHAN. We have no enforcement authority now.

Mr. DADDARIO. I mean recognizing that, if you had the enforcement authority you would know what to do. There is no secret to this business, if you agree that that is so.

Mr. VAUGHAN. I have not considered this because I am living in the world of our present authority.

Mr. DADDARIO. I understand that. But the present authority notwithstanding, the solution to that dump-burning problem certainly is something that we are technically capable of doing.

Mr. VAUGHAN. Yes, sir. We are technically capable, but having the technical knowledge and getting the job done, are in some cases, two entirely different things.

Mr. DADDARIO. That means that we have to develop some kind of a relationship and regulatory situation so that we can accomplish our objective. People will have to learn to put their solid wastes in a disposal basket and not throw it out in the street and clutter up the landscape.

Dr. Wolman was on television a couple of nights ago and he referred to this character of our society as the great American slob. He was not casting a reflection on the whole society, of course, but just trying, as I understood it, to call attention to the fact that we do a lot of things which add to the solid waste disposal problem because there is no incentive to do otherwise.

It is not a question of regulations. It is not a question of technical capability, but just a lack of will to do certain things. I think this is a different problem than the example you gave of the open burning dump, which short of regulation can be a hazard.

Mr. VAUGHAN. In this case, the citizens passed regulations which prohibited this from coming about. This was not a defined regulatory authority.

Mr. DADDARIO. Now you are talking about the open dump?

Mr. VAUGHAN. Yes, sir.

Mr. DADDARIO. We are probably spending too much time on this particular question, but I am trying to distinguish in my own mind your attitude about these things.

Here, certainly, a social science research program could help put it together so that these things can be done. It would appear to me to be part of the problem.

Mr. VAUGHAN. Yes, sir.

Mr. DADDARIO. I recognize that you have some problems, Mr. Vaughan, in this matter of open burning dumps. There was some serious debate during the course of the legislation on the disposal of solid wastes and Mr. Harris did say that the purpose of this program, and I am quoting from his remarks on the House floor, is "* * * research, investigation, training, surveys, studies, and demonstrations related to the operation of a solid wastes program."

Prior to that he indicated that enforcement would be an unnecessary invasion and interference by Government in a problem that should be primarily local. These are legal and constitutional problems which somehow must be overcome.

I do think, in your handling of the solid waste problem, that you have to distinguish the one from the other, and not get them mixed up.

That is difficult to do but not impossible. There are things which we find presently impossible but need not be if we do the research necessary to overcome them.

Mr. VAUGHAN. I agree with you. I pointed this out. There are many steps along the ladder to good solid waste management. Getting new technology to find answers we don't have is one of them. Getting known technology implemented is another.

Incinerator technology represents a pressing problem facing many solid waste managers and city officials today. Incineration of solid waste is a volume reduction technique to materially reduce the amount which must be ultimately disposed by some other techniques such as land disposal. Since combustion of waste is an integral process of all incinerators, air pollution can and has resulted unless effective control measures are utilized. Furthermore, inadequate or improper design and/or operation have resulted in pollution of our land and water resources. Some cities have received rather shocking news lately when construction bids have been opened on incinerators which have incorporated air pollution control devices required by regulatory officials. The increased capital investment and operation unit costs represent a one-third to one-half increase over costs previously associated with this type of disposal facility without effective air pollution controls. We believe that all incinerators must be designed and operated to assure adequate protection of our air and water resources. We, however, are appalled when these increased costs prevent effective community action to eliminate open burning in dumps, and incineration in outmoded facilities which cannot even be modified to assure efficient operation and protection of air resources. The answer to this debacle in our opinion is to either find effective substitutes for costly incineration or where this does not appear to be feasible, develop new incineration methods which are economically feasible and effective in controlling air pollution. The Public Health Service's solid wastes program is addressing itself to both approaches.

Mr. DADDARIO. Who is doing this kind of thing?

Mr. VAUGHAN. Aerospace. Combustion power section of Aerospace. This is a research firm in California.

Mr. DADDARIO. My question is, what level has this reached? Are you actually in demonstration?

Mr. VAUGHAN. No, not yet. We are in the research and early development stage of it.

Mr. DADDARIO. You are working on this. I would expect there would be other areas of incinerator development that you are working on?

Mr. VAUGHAN. Yes, sir.

Mr. DADDARIO. If that is the case, we would like you to provide that for the record.

(The information referred to follows:)

The City of Brockton, Massachusetts, supported by a Public Health Service solid waste demonstration grant is evaluating a newly developed ultra high temperature incinerator purported to have low capital and operating costs and great flexibility in the size and type of solid waste it can receive. This incinerator operates at such a high temperature that it produces an inoffensive residue which can be used widely in many community operations in lieu of gravel. The inventors claim the high operations temperature will greatly reduce the need for air pollution control devices and thus lower the costs even more. If the evaluation proves successful, a demonstration in an appropriate community could follow and perhaps a major contribution in incinerator technology.

Through the contract mechanism the Solid Wastes Program is in the process of developing a new concept in incineration which may lead to a major breakthrough in incinerator technology. Many incinerators here and abroad have considered utilization of waste heat to lower the net cost of operation by generating steam for purposes of heating or electric power generation. Our new approach takes advantage of jet engine technology to transform waste heat from combustion directly to a gas turbine and generate electric power with far greater efficiency and thus lower net cost. If this method, which includes effective air pollution control devices, proves to be as successful as it now appears likely, the net cost of operation may be substantially lower than present incinerators operating *without* any air pollution control devices.

Mr. DADDARIO. If we can go back a little bit, you talk about inadequacy in proper design and the increase in costs, and use Brockton as an example. That could be an improvement or it could be faraway wish to accomplish what they want to. How do you give some guidance on that so that successful salesmanship does not allow a community to buy something?

This city of Brockton could accomplish everything that you indicate it might. At the same time, you are not endorsing it.

Mr. VAUGHAN. That is right.

Mr. DADDARIO. It may very well have been sold on the basis of what it could accomplish, not what it does, and found itself in the category of inadequate design and excessive cost. How do you consider the restrictions under which you must operate and bring some order to this?

Mr. VAUGHAN. The city of Brockton has put in for a demonstration grant to evaluate an existing incinerator with the prospect of demonstration. This is a prototype. It is a pretty good sized one. I think it is about 150 tons a day, which is a fair-sized incinerator. There has been no evaluation, technical evaluation of this particular piece of equipment. We are in no position to say, as you say, whether it works or not.

This evaluation and demonstration grant will be operating for a period of time in which the equipment will be tested thoroughly and then they will know and other cities will know whether this would be worth while and whether the salesman's talks are true or not. It will be evaluated by a consulting firm hired to carry out specifications which we have provided them, so that we know that the tests will be thorough enough to give us a picture—and the rest of the people that are interested in this—a picture of whether (1) it will operate at about the financial level that they indicate; (2) whether it is effective in doing all the things they say; (3) how effective it is in preventing air pollution.

Mr. DADDARIO. You have some research activity going on in the field of incinerators, as you indicated.

Mr. VAUGHAN. Yes, sir.

Mr. DADDARIO. You also have, according to what you just said, a development capability to give some guidance to communities looking to better devices in the incinerator field?

Mr. VAUGHAN. Yes, sir.

Mr. DADDARIO. With some ability to assist them in coming to a judgment as to whether or not this is good, bad, or indifferent?

Mr. VAUGHAN. That is right. This was one of the directives of the act, as I remember. I don't remember the exact section where we were to give such guidance to cities; more in the form of information.

Mr. DADDARIO. My question is, Do you have that capability?

Mr. VAUGHAN. Yes.

Mr. DADDARIO. I wonder if you could provide for the record what this involves.

Mr. VAUGHAN. Yes, I can.

(The information requested is as follows:)

At the present time the most commonly used alternative to incineration is land disposal. The sanitary landfill is currently recommended as the most desirable technique. This method prohibits burning at any time, is designed and engineered to prevent pollution of ground and surface water, and is covered daily with an adequate layer of clean earth to prevent insect and rodent infestation and eliminate other insults to our environment. Too often the sanitary landfill degenerates into an open burning dump through poor operation—giving this method a bad name. If not used instead of incineration some method of land disposal is generally used with it to dispose of residue and outsized material which cannot be handled by the incinerator. Rising land costs and shortages of suitable areas have restricted use of sanitary landfill as have such factors as lack of citizen acceptance because of bad publicity. When public opinion or lack of available land forces the location of this operation long distances from the source of the waste, the resultant transportation cost may equal or even exceed the savings one might expect from land disposal as opposed to proper incineration. Lack of reliable information concerning settlement of sanitary landfills and the effects of methane gas produced as a result of decomposition of buried and compacted solid waste have also hindered effective utilization of this technique.

Mr. DADDARIO. We would like some examples to illustrate just how this is progressing.

Mr. VAUGHAN. I would be happy to.

Mr. DADDARIO. Where?

Mr. VAUGHAN. The United States. There is lack of information but we are studying it in California.

Mr. DADDARIO. When you say the United States, where in the United States specifically?

Mr. VAUGHAN. Almost wherever sanitary landfills are used in the planning of this ultimate utilization when they are finished. Very little information is available on precisely how much settlement one could expect, or precisely the problems that would occur from methane gas and odors, or uneven settlement.

We are trying to find out two things—exactly how to better understand it, and second, how can you control these problems so that you can use the land after it is finished for other purposes. It may be nice to use it for a park but perhaps you can use it for more than this.

Mr. DADDARIO. What is the methane gas problem? What proportion of danger are you including in your remarks? When you talk about methane gas, where in the country have you found it to be a danger so that it causes you to include it in your remarks this morning?

Mr. VAUGHAN. In California. Southern California. Los Angeles.

Mr. DADDARIO. How does it show itself to be a danger?

Mr. VAUGHAN. It shows itself to be a problem in three ways: (1) in uneven settling of land over the fill; (2) from odors which emanate from cracks; and (3)—this is not too well understood—methane gas traveling laterally into housing areas.

Mr. DADDARIO. Can we assume from that that is a serious problem?

Mr. VAUGHAN. I don't know how serious it is. This is what we are trying to find out.

Mr. DADDARIO. We don't know how serious it is. Then we are in an area where there is the possibility we have a dangerous situation. Therefore, we would need to develop new techniques altogether for the storage of such solid wastes.

Mr. VAUGHAN. That is correct. That is the purpose of our work there. To more fully understand this problem and, if necessary, develop operational procedures which control or eliminate it.

Mr. DADDARIO. As of the moment we haphazardly dump waste and, as we have in the past, assume that it is going to be safe when there are indications that it is not.

Mr. VAUGHAN. There have been some intimations it might be a dangerous problem in very specific circumstances. I don't fully understand this. Most of the complaints have been from odors.

Mr. DADDARIO. It is certainly something that ought to be ascertained?

Mr. VAUGHAN. Yes, sir; it sure is. We are proceeding on this.

Mr. DADDARIO. If it is, since it is an offensive odor, it might be dangerous and there is sufficient reason for us to be concerned?

Mr. VAUGHAN. This is the reason for our undertaking this work.

Mr. DADDARIO. Again, if you could provide for the record how you are structured in order to take care of this, who is involved, and what kind of a future commitment do you need to make from the management point of view and whatever else goes with that, to overcome that problem?

Mr. VAUGHAN. All right.

The Public Health Service is approaching these problems on the basis that land disposal properly designed and conducted is an exceptionally desirable form of solid waste disposal. Air and water pollution are effectively controlled and land reclamation can be accomplished. I cannot say enough about the potential of land reclamation through the disposal of solid wastes. The State of Maryland partially supported by a solid waste demonstration grant is showing how solid waste can be used to reclaim strip mines. This could change a blight of America into a precious asset and at the same time effectively deal with a pressing community problem—solid waste disposal. Another demonstration grant to the Chicago Sanitary District will show how sewage sludge after its removal from waste water can be transported to low cost land and converted into a profitable resource of agricultural and recreational purposes. Perhaps the most infamous example of solid waste disposal, the Kenilworth dump in Washington, D.C., is being converted into a model sanitary landfill operation which will ultimately be transformed into a tree-lined, grass-covered park and recreational area. There is no reason why necessary community functions cannot result in a community asset if technology can but respond to the challenge.

The high cost of transporting solid waste to available land has limited use of land reclamation techniques especially in the eastern part of the United States where these distances can be substantial. A Public Health Service demonstration grant to the American Public Works Association is partially supporting a study and demonstration of the use of railroad facilities to haul solid waste from crowded urban centers to areas where land is available for disposal and reclamation. This appears to be an exceptionally economical method of joining available land with great volumes of solid waste and is potentially a new innovation in solid waste management of major proportions. This could open new avenues which would allow consideration of alternatives in this field heretofore considered unthinkable. We are working closely with the American Public Works Association to make certain the results of their investigation are made available to solid waste managers as soon as possible.

Mr. DADDARIO. I am pleased to hear all that. But aren't you more optimistic than you ought to be in what this is accomplishing?

Mr. VAUGHAN. I don't think so.

Mr. DADDARIO. You say the State of Maryland is showing how solid wastes can be used to reclaim strip mines. There you are assuming this will happen, and you are extremely optimistic this is in fact going to happen. You use the Chicago example to show this can be transported to low-cost land and converted to a profitable resource for agricultural and reclamational purposes.

My understanding is that the Chicago situation does not really reach that particular goal.

I understand from what I have read about this that the hauling of solid wastes from crowded urban centers for reclamation by your Public Works Association does not in fact appear to be an exceptionally economical method of joining available land with great volumes of solid waste and is potentially a new innovation. I think these are nice statements and they can be said, but it becomes a matter of whether or not they really have a right to be that optimistic. I am not complaining about it, but I do think it is dangerous for us to come to optimistic conclusions in places where it might be better to be a little bit wary.

Mr. VAUGHAN. That is your view, sir. I am still optimistic and I have every confidence this will work. If it does not work, it does not. The work that has been done so far, which I reviewed last week again, it is getting more encouraging all the time.

Mr. DADDARIO. I think you should provide the specifics for the record, because we cannot possibly in a morning's hearing cover every point. I think it is going to be necessary for your people to sit down and prove these points out. I would like to be able to have the record show that we have a right to be optimistic. I would hope that you would be able to provide that.

Mr. VAUGHAN. A solid waste demonstration grant awarded to Raleigh, N.C., is demonstrating the systems analysis approach to this problem by the application of a mathematical model developed by a Public Health Service research grant to Northwestern University. This organized approach designed to maximize economics involved in collection of solid waste could result in significant savings to taxpayers across the Nation. Through the contract mechanism, we are obtaining an evaluation of the collection of solid waste using specially designed vehicles with one-man crews. The potential savings of such an approach is even more obvious when one considers that labor cost is the main factor in the overall cost of collection.

A demonstration grant was awarded to the town of Barrington, R.I., to demonstrate the feasibility of year-round solid waste storage and collection using paper bags and special holders provided by the municipality. The effect of this method on collection and disposal practices was also demonstrated.

Agricultural wastes including animal wastes are included in the Nation's solid waste contribution to an extent not realistically considered by the average citizen. Reliable estimates of the magnitude are not only available but preliminary estimates indicate this contribution exceeds 1 billion tons per year.

Public Health Service solid waste research grants awarded to Purdue and Rutgers Universities are supporting study of new methods to dispose of dairy and poultry manure. A demonstration grant awarded to Washington State University is demonstrating facilities and techniques that will reduce the possibility of water pollution and increase the fertilizer values actually realized from dairy manure.

There are several special solid waste problems caused by technological advances in a particular industry or by other sociological and economic progress. As urban renewal and slum clearance grows, what does one do with the mountains of demolition material which results from this endeavor? Our country is the most affluent society in the world and has to worry about more abandoned automobiles than any other country has traveling down their highways. Sophisticated methods have been developed by private industry to compact and reclaim these vehicles but how about transporting them economically to the site and preparing or stripping them for disposal or reclamation without causing air pollution? Old railroad cars have for decades been ignited to dispose of the wooden portion and allow salvage of valuable metal parts. This can no longer be tolerated because of the threat to our air resources—but what do we do with them?

A Public Health Service research grant to New York University supported the development of a special incinerator to handle demolition material and other bulky solid wastes economically and effectively control particulate emission to protect air resources.

We would be glad to have our staff sit down with yours and give them whatever information they need.

The cost of collection of solid waste at its source and transportation of this material to a disposal site is estimated to be about 75 percent of the current total cost of handling solid waste. It is evident that the development of methods which improve technology and lower the cost of collection will materially affect the overall solid waste management picture.

Mr. Daddario. Hold it right there a moment.

Dr. Hibbard, we had some discussion on this problem when you appeared before the committee some time back.

As I recall it, your statement included the possibility of mixing solid wastes with taconite for certain steel production purposes. This does fall in this category. I wonder what comment you might have about where we stand in that at the moment?

Dr. Hibbard. This subject is covered in my prepared statement, Mr. Chairman.

The procedure is technically feasible. We have carried it out in a pilot plant and we have plans for a demonstration plant at Hibbing, Minn. The funds for this plant have been put in reserve due to the current budgetary situation so there is a stretchout involved here.

This approach would have two advantages. It would not only use the scrap automobiles but it would also be the means of getting rid of the piles of taconite which are part of the solid waste management problem. And it will minimize the cost of both of these objectives.

The problem, however, is the one that Mr. Vaughan has identified: How can these junk automobiles be transported to the site where they can be most effectively used or disposed of?

Mr. DADDARIO. Mr. Vaughan.

Mr. VAUGHAN. To continue, the incinerator developed by the research contract is now being constructed as a demonstration project at Stamford, Conn. The contract mechanism is being used to develop effective ways of dismantling old railroad cars to eliminate air pollution caused by burning these vehicles in the open.

Mr. DADDARIO. We have plenty of old railroad cars.

Mr. VAUGHAN. We sure have.

One approach is a special technique which eliminates burning altogether. A jet of high pressure water is used to cut through the wood and separate the metal fittings from the body of the car. This technique is being further investigated to see see if it might have value in stripping unwanted material—rubber, upholstery, et cetera—from abandoned automobiles prior to their disposal without utilizing incineration techniques. The technique might also be used to reduce the volume of bulky wastes.

A very special problem is now facing those in the Nation concerned with the disposal of solid wastes. This is the problem associated with packaging materials and disposable containers. The problem is really twofold. First, the increased use of this material in recent years has caused a significant increase in the volume of sold wastes that must be handled by the community; and, second, the nature of the disposable material is such that much of it is not amenable to decomposition and, therefore, presents special disposal problems. "Eternal" plastic and "unrustable" aluminum have made their way into solid waste technology and must be coped with if we are to effectively manage solid wastes.

A contract was awarded to study feasible methods of disposing of polyethylene plastic waste while another contract was awarded to the Midwest Research Institute to make a thorough study of packaging materials, trends in this industry, and possible solutions which would be amenable to solid waste disposal without hurting the industry. A part of this study includes the consideration of needed legislative programs to cope with this problem. I shall refrain from further comment on this subject since this committee will hear from a representative of Midwest Research on this important problem. When this study is received, it will be evaluated by our technical personnel and our future course of action determined.

The Solid Waste Disposal Act also directs the recover and utilization of potential resources in solid wastes. Transformation of solid waste into a beneficial product has the advantage of disposing of a waste product, conservation of natural resources, and economic benefit which lowers the net cost of disposal.

A Public Health Service research grant to the University of Florida is supporting development of a method to convert citrus processing plant waste to citric acid. Another research grant to the University of Maryland is supporting investigation of the possibility of transforming wastes formed in the production, packaging, and canning of vegetables and cheese, to new foods or food additives.

The research staff of the solid wastes program has a section devoted to the development of new uses for solid wastes. One internal project is attempting to transform cellulose from solid waste into sugars. Another project stresses the possibility of chemical transformation of solid wastes into protein. Still another is attempting to transform waste rubber into useful new rubber materials by improvement of separation techniques and changing technology to allow a greater proportion of used rubber in new products. Other internal research studies are studying the recovery of useful inorganic and organic compounds from incineration residue, animal, and vegetable wastes.

One method of solid waste disposal resulting in a useful end product is composting. This method has received much publicity during recent years—some good and some bad. Some plants were built to receive the municipal wastes of a municipality and closed their doors within a year while some have operated for years. We, too, wonder what the true story of composting as a solid waste disposal process in this country is.

What are its technological requirements? What are its economic considerations? What is its likely future as a major method of disposal of solid waste?

To answer these and other questions an in-depth study of composting was undertaken jointly with the Tennessee Valley Authority. This joint PHS–TVA composting project at Johnson City, Tenn., will evaluate composting of municipal solid waste and sewage sludge. The plant has been completed and is now operating. Studies will be made to determine:

(1) Potential agricultural use of the product;

(2) The marketing potential of the compost, including geographic limits of the marketing area; and

(3) Public health hazards involved in the use of this product.

Operating guidelines will be developed to assure maximum efficiency and plant environmental conditions will be evaluated. At the conclusion of this project the data gathered should permit a thorough and unbiased evaluation of this practice. The evaluation will include net cost figures and likely estimates of the market one might expect. There seem to be few neutral parties concerned with learning the whole story about this controversial method of solid waste disposal. We hope to shed much insight into this important matter.

Mr. DADDARIO. What is your time schedule in sharing this insight?

Mr. VAUGHN. July 1, 1969, is the target date for our first report. Actually, the project is in operation now. One final processing grinder is the only thing that keeps it from being complete and the evaluation beginning.

Mr. DADDARIO. Taking your previous sentence into consideration, when you have this information do you intend to be one of the few neutral parties?

Mr. VAUGHAN. Not at that time. We will take a stand as we see the picture.

Mr. DADDARIO. You seem to indicate we need more neutral parties.

Mr. VAUGHAN. What I meant by the statement, Congressman, is right now it seems to me people are for it 100 percent or against it 100 percent. Maybe middle ground is the better position. We want to know more about it before we decide in our opinion what role it has in the solid waste practices of the Nation.

Mr. Daddario. You expect when that time came you would not be a neutral party if it is something that would be necessary to accomplish in this area?

Mr. Vaughan. Yes. Perhaps "neutral" would refer to not having our mind made up one way or the other.

The protection of the Nation's health is a primary responsibility of the Public Health Service. Consideration of the health hazards involved in solid waste management is no exception. There are many health hazards associated with the flies and rats which frequent open dumps and areas where improper collection and storage of solid waste is practiced. Not so well known, however, are the health hazards involved in the collection of wastes. Those who perform this task are engaged in one of the most dangerous jobs in existence. Through the contract mechanism, a study was made of the relationship between disease and solid waste. The research staff of the solid wastes program is now evaluating current solid waste handling practices and will evaluate new methods as they are developed to assure that the public health is being properly protected as scientific technology advances.

Mr. Daddario. I have your solid waste-disease relationship and literature study, Public Health Service, U.S. Department of Health, Education, and Welfare. In the summary and conclusions you say:

> The literature fails to supply data which would permit a quantitative estimate of any solid waste-disease relationship. The circumstantial and even epidemiologic information presented does support a conclusion that as to some diseases solid wastes bear a definite, if not well-defined, etiologic relationship.

What does that mean? You seem to be talking about two things. You seem to be wording it so you can be on both sides of this. You say there is no waste-disease relationship, that "does bear a definite if not well-defined relationship." What does that mean?

Mr. Vaughan. What page is that?

Mr. Daddario. This is on page 5 of your prepared statement. It seems to me to fall into one of those categories of saying everything and saying nothing. Yet, it is under summary and conclusions.

You say "definite but not well-defined." How can it be both? We are talking about health and one of the problems in this whole area of pollution is we know so little about the effect it does have on health. I think it is important to say those things which can develop confidence rather than a lack of confidence and a statement of this kind seems to me to be one which would not do that.

Mr. Vaughan. I interpret this statement to mean that the problem of insects and rats as disease carriers and pests is known. The precise relationship of this problem to the solid waste problem is not yet defined. The problem of air pollution as a health hazard I think has been pointed out by the people from the National Center for Air Pollution Control. I do not think it has been precisely defined, however, how much of that comes from the burning of solid waste. Let's hope this relationship can be better determined.

Mr. Daddario. I agree with that last statement. That is something we will go into, and it does seem to me this is precisely the kind of statement we have to be extremely careful about. We are trying to accomplish so much and this is one of the reasons I thought perhaps you were too optimistic in some of these other areas. I do not mean we ought to be pessimistic, but we must be realistic. We sometimes reach out and find ourselves saying things we ought not to. When we do—it is something we are all guilty of from time to time—we then spend more time working our way out of it than it is worth. We are at the time and place in this whole area of pollution where I think we can be extremely realistic. We must be.

Mr. Vaughan. Yes.

Our research studies include investigation of the hazardous materials in refuse, pathogens associated with incineration processes, and occupational hazards of solid waste handling. One might assume that the residue following incineration would be almost sterile. Preliminary investigation by our staff has discovered this is not necessarily true and surveys at several plants indicate gross contamination of this material with pathogenic organisms. Further investigation will determine the magnitude and applicability of this finding and hopefully develop an effective way of using this technique to determine the effectiveness of incinerator operation.

The studies of the occupational hazards of solid waste handling are being jointly undertaken by the research staffs of both the occupational health program and the solid wastes program of the National Center for Urban and Industrial Health, and will be devoted to reducing the accident and disease rate by pointing out defects in present technology which contribute to these rates. The studies will also help in the development of technology which is both effective, economic, and safe.

The most advanced technology can be used to develop a magnificent incinerator or sanitary landfill or compost plant capable of doing the job economically and effectively, but if it is not operated properly you have not accomplished a thing. In our rapidly changing world, great stress is placed upon new technology and scientific achievement, but woefully little attention is given to teaching the man who must operate the facility how to run it and making sure he does a good job. New technology is needed in this area just as much as in those areas normally considered scientific. How do we assure proper operation of multimillion-dollar structures?

The American Public Works Association is developing for the Public Health Service a comprehensive blueprint for the training of operating personnel in the field of solid waste disposal. This project, supported by a Public Health Service contract, will also identify and measure training needs to help guide those who will carry out such training. The technical staff of the Public Health Service's solid waste program is currently developing guidelines for the operation of sanitary landfill and incinerators using well-known authorities in these areas as consultants. Both reports are to be completed this year.

Perhaps the most difficult obstacle in getting new technology adopted and implemented is the reluctance of the public to accept solid waste disposal in the communities and the equally severe reluctance of communities to work cooperatively together to come up with one approach to solid waste management that is best for all the municipalities which make up a region or metropolitan area. People want their solid wastes problems solved but not near their home or near their community. Many small suburban communities know they could get by more economically by combining forces with others, but many times prefer to go it alone to preserve their autonomy.

The Public Health Service, through public information technology, is trying to gain public recognition of the solid waste problems and gain public support for local solution to these problems. Certain demonstration projects such as the transformation of the Kenilworth dump to a model operation and land reclamation activity are designed to gain public support for proper solid waste management. A contract with the National Association of Counties is developing a program designed to educate public officials in solid waste needs, problems, and solutions.

Stimulating communities to work together on a regional or metropolitan basis is being approached by the Public Health Service's solid wastes program through the mechanism of study and investigation grants to demonstrate how communities overcome the legal, interjurisdictional, and public opinion difficulties in approaching their common solid waste problems on a regional basis. The regions being studied include metropolitan areas such as Louisville, Ky.; Erie, Pa.; New Orleans, La.; Des Moines, Iowa, and Oklahoma City, Okla. They also include entire counties such as Maricopa County, Ariz.; Fresno County, Calif.; Genesee County, Mich.; Jefferson County, Wis.; and Harrison County, Miss. Low population density regional areas are included such as the area near Farmington, Conn., and Great Falls, Mont.

The studies also include special regional areas such as the Tocks Island Recreational Area encompassing part of three States, several economically depressed counties in Appalachia, and the Quad-City area in New Jersey. The results of these studies will bring to light approaches which can be used by other communities with similar problems and similar circumstances, thus improving psychometric technology and providing answers which quite frankly have us and most of the country stymied at the present time.

I have pointed out to you many problem areas and have described our approach to their better understanding and solution. I am confident methods will be found which will allow air and water pollution control criteria to be met—methods which are technologically sound, economically feasible, and safe from the standpoint of protection of the public health and our environment.

Lest my remarks here today be interpreted as a deterrent to the use of current technology to solve existing solid waste management problems until a major breakthrough is made, let me set this issue straight right now.

There are no legitimate reasons (except perhaps financial) to hold up the immediate elimination of open burning dumps. The remodeling or replacement of antiquated incineration facilities without effective air pollution control devices, the abandonment of open broken-down collection vehicles which spew solid wastes along the route to the disposal site, and the cessation of feeding garbage to hogs. The Nation can improve its solid waste disposal practices—and it can do it now. We have the technology to do it now—and we are working to improve this technology and develop techniques which are not only more effective but more economical as well.

I feel personal sadness when I consider that the beautiful whooping crane is close to extinction. On the other hand, I look forward with a great deal of zeal, enthusiasm, and pleasure to one of the goals of the solid wastes program—the elimination of the open burning dump from our society. This disgrace to humanity truly belongs to history, not to the present, and certainly not to the future.

In conclusion, I would like to state that the Public Health Service is facing the technological problems I have mentioned today with vigor and enthusiasm. Some of the approaches we are using will succeed and some will fail. We are confident, however, that their undertaking will furnish technological facts for more effective solid waste management and a better and cleaner America.

I appreciate the opportunity to discuss the solid waste management activities of the Public Health Service with you today.

Mr. **Daddario.** Thank you, Mr. Vaughan.

Questions submitted to Richard D. Vaughan by the Subcommittee of Science, Research, and Development.

Question 1. Solid wastes not only are precursors of air and water pollution but appear again as the result of waste treatment—i.e., the sludge from sewage plants and the residue from incinerators. are these latter residues ultimately going to have to be buried? What is the forecast for burial site acreage in the Northeast megalopolis? Can these solids be dumped at sea?

Answer. Most areas must use a form of land disposal for sewage sludges. In some coastal areas these sludges may be hauled to sea. At present, the ultimate disposal of the residue from incinerators is invariably upon the land. Present incinerators produce residues of varying quality, most of which must be disposed of by burial. There is no indication that this residue quality will be greatly improved and therefore, it is believed that residue burial will remain as a required practice. There is every expectation that much of the sludge and incinerator residues produced will always have to be disposed of by land burial. The total amount that will have to buried will be directly influenced by the suitability of recovery and utilization processes as developed through the Solid Waste Program's efforts.

A summary of the present burial site acreage available in northeast megalopolis is unavailable at this time, a forecast of future sites would certainly produce an inaccurate appraisal of the situation.

There does not appear to be any technical impediment to the use of land for the proper disposal of sludge and incinerator residues either now or in the foreseeable future. The major limiting consideration is the cost involved in transporting and disposing of such wastes, not the amount of land available for their disposal. Studies are underway to solve this problem through better transportation methods, improved volume reduction methods, and advanced disposal techniques.

The technology concerning sea waste disposal is for all practical purposes nonexistent at this time. Until adequate technical information is available on the degradation and movement of these materials when dumped at sea it is impossible to adequately answer any question concerning the suitability and desirability of such disposal practices. It is possible that advanced technology may allow us to safely dispose of solid wastes at sea just as we now dispose of solid wastes in other environmental areas.

Question 2. When solid wastes from municipal collection of trash is incinerated, what is the volume reduction? What is the weight reduction? What is the magnitude of the disposal problem of incinerator residue for a large incinerator?

Answer. The volume reduction obtainable by municipal incinerators (as well as the weight reduction) depends almost entirely upon the configuration and operation of the particular facility. A 75% reduction in both weight and volume of municipal refuse is considered to be the average result of incineration today.

The magnitude of the incinerator residue problem is not only dependent upon configuration and operation, it is also dependent upon the size of the furnace and the amount and type of the refuse charged. Many very large incinerators minimize the residue problem by doing an efficient job of volume reduction. It is also just as common to see a municipal incinerator poorly operated, producing a very minimal volume reduction. If the present day incinerators could produce, under normal operating conditions, a sterile, stable residue, the problem of residue disposal would be considerably decreased.

Question 3. What are the comparative areas required for composting versus incineration and other methods?

Answer. Municipal incinerators and composting plants consisting of mechanical digesting facilities require approximately the same space for plant installation. The windrow method of composting, however, requires a considerably greater space since much of the digestion of the solid wastes takes place in open windrows upon composting aprons.

Both incineration and composting are volume reduction methods and additional areas are necessary for the final disposition of those materials which cannot or were not incinerated and those materials which cannot be composted nor have salvageable value. Using present techniques those additional areas required would be approximately equal for the two methods considered. We would predict that the amount of land for each type of operation, at least for the initial facility installation, is expected to change with the development and introduction of need salvage and recycling techniques. These techniques are expected to become increasingly important to solid waste management officials during the next decade.

Question 4. What is the present status of the operations of composting plants in the United States? What has been the experience over the last ten years? What have been the fiscal experiences for plants serving less than 50,000 and more than 500,000 people? Realistically, how applicable are such procedures as composting in the economy of the United States?

Answer. An evaluation of the composting plants status in the United States over a period of ten years reveals that of the 17 composting plants proposed to compost municipal wastes only 4 are presently maintaining a reasonably continuous operation. Two of the 17 were never constructed—the other 15 plants have had varying operating experiences ranging from less than one year to five years. We have been unable to discover any correlation between the size of population served and fiscal experience of the plant. Reliable technical and economic data on composting is not presently available—it is possible that a correlation could exist.

Dr. Samuel A. Hart in his report to the United States Public Health Service upon the subject of "Solid Waste Management: Composting—European Activity and American Potential" summarizes the potential for composting and compost utilization in the United States as follows: "It appears to the author that there are no real technological barriers to making compost. It does appear, however, that the utilization of compost is limited. There are successes in luxury agriculture, as evidenced in vineyard, flower, and landscaping uses, but basic agriculture cannot be expected to absorb the material. Further, the concept of composting must be considered from the municipality's viewpoint. Most municipal officials recognize that it is not possible to make money from garbage. The most that can be expected, with regard to composting, is that the net cost to the city for garbage disposal by composting will be less, or no greater, than the costs of disposing of the garbage by landfilling or incineration. The gross cost of composting could be more if a return could be realized on the sale of the compost, or a value could be put on the intangible factors of reduced rate of consumption of burial sites or reduced air pollution relative to incineration.

It does appear that in the United States there are three specific areas in which refuse processing and discharge through composting have real potential:

(1) Small amounts of compost can be marketed for luxury agriculture, in which case the overall economics—to the producing municipality and to the user—are favorable.

(2) The finished compost has value, but the economics—for the producer or for the user—must be related to intangible values.

(3) The finished compost is either not valuable or only marginally so, but the overall economics are nonetheless favorable. . . .

At this stage it is impossible to estimate what percentage of the nation's garbage might be so managed. It would appear that this system might have merit for communities with populations between 10,000 and 100,000. There are 1,760 such communities in the United States, with a total population of nearly 50 million, or 25% of the nation. If this method of refuse disposal were appropriate or even one-third of them, it would be a substantial avenue of waste disposal."

Question 5. Are there any results available as yet on system analysis or operations research, which would improve collection procedures or would provide more economical handling? What significance have the studies in California and elsewhere had by the application of systems analyses to the problems of collection and disposal?

Answer. Exceptionally few significant systems analysis projects in solid wastes have progressed beyond the first phase; analyzing present sytems and developing conceptual models. Preliminary results from some first phase attempts indicate that meaningful results will be forthcoming. Much of the work is in the descriptive stage and problem solving is not significantly present in either the California studies or elsewhere.

Question 6. Are there any examples in the United States as elsewhere of new collection techniques or equipment or both?

Answer. Very few new collection techniques have been developed within this country or abroad. National efforts have been towards the improvement of current equipment design and optimization of current collection practices. A bigger and better compactor truck is an example of this practice. Similarly, the development of smaller, more mobile collection equipment such as the scooter or train system or the containerized technique for handling commercial, industrial, or high residential density wastes is also a current practice.

The Swedish pneumatic system or the liquid transport of ground solid wastes as being investigated at Drexel University is the closest thing to what may be a new collection technique. The research undertaken at Drexel University is in its very preliminary stages and cannot be considered as an imminent method for public use. The Swedish pneumatic system consists of a vacuum pipeline which moves refuse from piped apartment buildings to a centralized storage and disposal area. This system has not been tested in our country although we have reason to believe that an example of this collection system may be available in the coming months.

(Mr. Vaughan's prepared statement follows:)

PREPARED STATEMENT OF RICHARD D. VAUGHAN, CHIEF, SOLID WASTES PROGRAM, NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH, PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, CINCINNATI, OHIO

Mr. Chairman, I am pleased to be here today and welcome this opportunity to present a report on the adequancy of technology in the field of solid waste management and what the Solid Wastes Program of the Public Health Service is doing to close existing gaps in this technology. The Solid Wastes Program was established to carry out the directives of the Solid Waste Disposal Act of 1965 which has as its objectives:

(1) To initiate and accelerate a national research and development program for new and improved methods of proper and economic solid waste disposal.

(2) To provide technical and financial assistance to appropriate agencies in the planning, development, and conduct of solid-waste disposal programs.

In enacting this legislation Congress recognized the increasing problems of solid waste management which have been accentuated by continuing technological progress and improvement. The Congress also recognized the fact that inefficient and improper methods of solid waste disposal threaten the health and well-being of the Nation including interference with community life and development. Following the directives in this Act, the Public Health Service has established an organizational entity to address itself to these problems and find solutions for today and tomorrow and thus, assure adequate protection of the air, land, and water resources of this country from degradation through inadequate and improper management of solid waste.

During his testimony before this committee on July 21, 1966, Mr. Wesley Gilbertson, then Chief of the Office of Solid Wastes, discussed the history of federal activities in the solid waste management area and described the National solid waste problem as he saw it at that time. He described the Solid Waste Disposal Act and its provisions as well as the structure of the organization established by the Public Health Service to carry out the provisions of this legislation. Mr. Gilbertson pointed out to this committee, plans of the Office of Solid Wastes to learn more about solid waste practices in this country and hopefully close the technology gap in this area. I shall not repeat this information but rather would like to discuss with you what has been accomplished in the interim by the Public Health Service to better understand the adequacy of solid waste practices and problems in this country and develop effective technology to cope with these problems.

The improved technology we seek must satisfy other requirements in addition to being scientifically sound. These innovations must also be economically feasible for our society and must be safe from the standpoint of public health and the protection of our precious natural resources—our land, air, and water.

Technological development alone—no matter how effective, how economical or howe safe—will not do the job that is needed to be done to improve solid waste management in this country. Once new solutions are found and proven effective by research and development, their practicability and applicability to a real situation must be demonstrated. The public's attitude towards solid waste management must be changed to allow acceptance of new concepts. Communities which are jurisdictionally autonomous but collectively make up regional or metropolitan areas, must learn to cooperate and work together for the adoption and implementation of solid waste collection and disposal techniques which economically and effectively serve the best interests of all. No matter how innovative new technology is, the facilities involved must be operated properly to achieve the benefit intended by the developer. This then is the complete job of solid waste management—the approach to which the Solid Wastes Program of the Public Health Service is dedicated.

I should point out that the full financial and personnel resources of the Solid Wastes Program are utilized on an integrated basis to get the results we desire. Problem areas discovered in fact-finding surveys lead to intra and extra-mural research activity which in turn leads to development and demonstration activity to show the practicability of a solution. As a final step public information documents and solid waste training conducted by universities and the Public Health Service convey this information to personnel in the field to aid them in making wise solid waste management decisions and meet pollution control criteria imposed upon them by regulatory agencies. The lack of valid information effectively describing the present status of solid waste practices in the United States presents a major obstacle to effective assessment of the solid waste problem in this country and what type action programs should be undertaken to assure proper solid waste management now and in the future. The paucity of such information has been recognized in previous testimony before this and other committees investigating solid waste management in this country.

Recognizing this need, we have utilized State Planning Grants to help fill this void. These grants have been awarded to 38 State and interstate agencies to first survey solid waste practices within the State and then develop a comprehensive State solid waste plan. Our own technical staff are at this moment taking the results of all the surveys which have been totally or partially completed and preparing a report which for the first time will show, on a statistically reliable basis, the following:

(a) The magnitude of municipal and commercial solid wastes being handled in the United States today and future use projections.

(b) The type of disposal and collection techniques being used today and their frequency of distribution.

(c) The adequatecy of present practices.

(d) Solid waste management needs for today and for the future (financial and technological).

This activity has a high program priority and is scheduled to be completed this summer. At the same time our technical personnel are conducting specialized studies of selected industries to get better insight into the solid waste problems associated with industrial operation.

A solid waste information retrieval system has been established within the Solid Wastes Program and is now operational. Technical journals and other periodicals and reports have been abstracted, categorized, and catalogued. A researcher interested in what information is available in a broad or very specific field can inquire and be furnished appropriate material.

Incinerator technology represents a pressing problem facing many solid waste managers and city officials today. Incineration of solid waste is a volume reduction technique to materially reduce the amount which must ultimately be disposed by some other technique such as land disposal. Since combustion of waste is an integral process of all incinerators, air pollution can and has resulted unless effective control measures are utilized. Furthermore inadequate or improper design and/or operation have resulted in pollution of our land and water resources. Some cities have received rather shocking news lately when construction bids have been opened on incinerators which have incorporated air pollution control devices required by regulatory officials. The increased capital investment and operation unit costs represent a ⅛ to ½ increase over costs previously associated with this type of disposal facility without effective air pollution controls. We believe that all incinerators must be designed and operated to assure adequate protection of our air and water resources. We, however, are appalled when these increased costs prevent effective community action to eliminate open burning in dumps, and incineration in outmoded facilities which cannot even be modified to assure efficient operation and protection of air resources. The answer to this debacle in our opinion is to either find effective substitutes for costly incineration or where this does not appear to be feasible, develop new incineration methods which are economically feasible and effective in controlling air pollution. The Public Health Service's Solid Wastes Program is addressing itself to both approaches.

The City of Brockton, Massachusetts, supported by a Public Health Service solid waste demonstration grant is evaluating a newly developed ultra high temperature incinerator purported to have low capital and operating costs and great flexibility in the size and type of solid waste it can receive. This incinerator operates at such a high temperature that it produces an inoffensive residue which can be used widely in many community operations in lieu of gravel. The inventors claim the high operations temperature will greatly reduce the need for air pollution control devices and thus lower the costs even more. If the evaluation proves successful, a demonstration in an appropriate community could follow and perhaps a major contribution in incinerator technology.

The small community has been unable to utilize incineration because of the inability to take advantage of economy of scale. A demonstration grant to the City of Shippensburg, Pennsylvania is supporting the evaluation and demonstration of a small mechanically stoked rotary grate incinerator developed in West Germany which if successful will allow communities in the 25,000 population range to consider incineration as a satisfactory method of disposing of solid waste and effectively meeting air pollution control criteria.

Through the contract mechanism the Solid Wastes Program is in the process of developing a new concept in incineration which may lead to a major breakthrough in incinerator technology. Many incinerators here and abroad have considered utilization of waste heat to lower the net cost of operation by generating steam for purposes of heating or electric power generation. Our new approach takes advantage of jet engine technology to transform waste heat from combustion directly to a gas turbine and generate electric power with far greater efficiency and thus lower net cost. If this method, which includes effective air pollution control devices, proves to be as successful as it now appears likely, the net cost of operation may be substantially lower than present incinerators operating *without* any air pollution control devices.

Since the irregular size of solid waste can contribute to ineffective operation and actually produce greater amounts of particulate matter to pollute the air, a demonstration grant awarded to the City of Buffalo, New York, is supporting a demonstration of a crusher to effectively presize refuse prior to incineration and thereby increasing the efficiency and air pollution control effectiveness of the incineration process which follows.

At the present time the most commonly used alternative to incineration is land disposal. The sanitary landfill is currently recommended as the most desirable technique. This method prohibits burning at any time, is designed and engineered to prevent pollution of ground and surface water, and is covered daily with an adequate layer of clean earth to prevent insect and rodent infestation and eliminate other insults to our environment. Too often the sanitary landfill degenerates into an open burning dump through poor operation—giving this method a bad name. If not used instead of incineration some method of land disposal is generally used with it to dispose of residue and outsized material which cannot be handled by the incinerator. Rising land costs and shortages of suitable areas have restricted use of sanitary landfill as have such factors as lack of citizen acceptance because of bad publicity. When public opinion or lack of available land forces the location of this operation long distances from the source of the waste, the resultant transportation cost may equal or even exceed the savings one might expect from land disposal as opposed to proper incineration. Lack of reliable information concerning settlement of sanitary landfills and the effects of methane gas produced as a result of decomposition of buried and compacted solid waste have also hindered effective utilization of this technique.

The Public Health Service is approaching these problems on the basis that land disposal properly designed and conducted is an exceptionally desirable form of solid waste disposal. Air and water pollution are effectively controlled and land reclamation can be accomplished. I cannot say enough about the potential of land reclamation through the disposal of solid wastes. The State of Maryland partially supported by a solid waste demonstration grant is showing how solid waste can be used to reclaim strip mines. This could change a blight of America into a precious asset and at the same time effectively deal with a pressing community problem—solid waste disposal. Another demonstration grant to the Chicago Sanitary District will show how sewage sludge after its removal from waste water can be transported to low cost land and converted into a profitable resource for agricultural and recreational purposes. Perhaps the most infamous example of solid waste disposal, the Kenilworth dump in Washington, D.C., is being converted into a model sanitary landfill operation which will ultimately be transformed into a tree-lined, grass-covered park and recreational area. There is no reason why necessary community functions cannot result in a community asset if technology can but respond to the challenge.

The pancake-flat terrain around Virginia Beach, Virginia, will have a welcome hill for entertainment as recreational purposes, thanks to another PHS solid waste demonstration grant designed to effectively join land reclamation and solid waste disposal.

Through the contract and demonstration grant mechanism the PHS Solid Wastes Program is supporting a study and demonstration to develop effective methods for controlling methane gas production in sanitary landfills and diminishing its adverse effects on land use.

The high cost of transporting solid waste to available land has limited use of land reclamation techniques especially in the eastern part of the United States where these distances can be substantial. A Public Health Service demonstration grant to the American Public Works Association is partially supporting a study and demonstration of the use of railroad facilities to haul solid waste from crowded urban centers to areas where land is available for disposal and reclamation. This appears to be an exceptionally economically method of joining available land with great volumes of solid waste and is potentially a new innovation in solid waste management of major proportions. This could open new avenues which would allow consideration of alternatives in this field heretofore considered unthinkable. We are working closely with the American Public Works Association to make certain the results of their investigation are made available to solid waste managers as soon as possible.

We are actively supporting the development, evaluation and demonstration of new devices and techniques to reduce the bulk or volume of solid waste and allow greater utilization of precious land for sanitary landfill operations. Crushing, baling, or grinding devices in New York City, New York; Madison, Wisconsin; Tacoma, Washington; and San Diego, California partially supported by Public Health Service solid waste demonstration grants are demonstrating techniques of volume reduction of solid waste to effectively increase the life of sanitary landfills. Similar grants support the demonstration of refuse disposal machines in Lockport, New York and Seattle, Washington to effectively compact and place solid waste into the ground in a manner designed to prolong the life of the sanitary landfill.

The cost of collection of solid waste at its source and transportation of this material to a disposal site is estimated to be about 75% of the current total cost of handling solid waste. It is evident that the development of methods which improve technology and lower the cost of collection will materially affect the overall solid waste management picture.

A solid waste demonstration grant awarded to Raleigh, North Carolina is demonstrating the systems analysis approach to this problem by the application of a mathematical model developed by a Public Health Service Research grant to Northweastern University. This organized approach designed to maximize economics involved in collection of solid waste could result in signficant savings to taxpayers across the Nation. Through the contract mechanism, we are obtaining an evaluation of the collection of solid waste using specially designed vehicles with one-man crews. The potential savings of such an approach is even more obvious when one considers that labor cost is the main factor in the overall cost of collection.

Innovation technology in the collection field is being investigated by the University of Pennsylvania supported by a Public Health Service solid waste research grant. This project is determining the feasibility of transporting solid waste in pipes as a liquid slurry. Recently developed in Sweden a vacuum system is transporting solid waste in highly urbanized areas short distances in pneumatic tubes. This method is being evaluated by the technical staff of our own Program and if justified will be applied to an appropriate system in the United States.

A demonstration grant was awarded to the town of Barrington, Rhode Island to demonstrate the feasibility of year-round solid waste storage and collection using paper bags and special holders provided by the municipality. The effect of this method on collection and disposal practices was also demonstrated.

Agricultural wastes including domestic animal wastes are included in the Nation's solid waste contribution to an extent not realistically considered by the average citizen. Reliable estimates of the magnitude are not now available but preliminary estimates indicate this contribution exceeds one billion tons per year.

Public Health Service solid waste research grants awarded to Purdue and Rutgers Universities are supporting study of new methods to dispose of dairy and poultry manure. A demonstration grant awarded to Washington State University is demonstrating facilities and techniques that will reduce the possibility of water pollution and increase the fertilizer values actually realized from dairy manure.

There are several special solid waste problems caused by technological advances in a particular industry or by other sociological and economic progress. As urban renewal and slum clearance grows, what does one do with the mountains of demolition material which results from this endeavor? Our country is the most affluent society in the world and has to worry about more abandoned automobiles than any other country has traveling down their highways. Sophisticated methods have been developed by private industry to compact and reclaim these vehicles but how about transporting them economically to the site and preparing or stripping them for disposal or reclamation without causing air pollution? Old railroad cars have for decades been ignited to dispose of the wooden portion and allow salvage of valuable metal parts. This can no longer be tolerated because of the threat to our air resources—but what do we do with them?

A Public Health Service research grant to New York University supported the development of a special incinerator to handle demolition material and other bulky solid wastes economically and effectively control particulate emission to protect air resources. This incinerator is now being constructed by the City of Stamford, Connecticut, partially supported by a Public Health Service solid waste demonstration grant.

The contract mechanism is being used to develop effective ways to dismantle old railroad cars to eliminate air pollution caused by burning these vehicles in the open. One approach is a special hood enclosing the entire car, but one of more promising value is a technique which eliminates burning altogether. A jet of high pressure water is used to cut through the wood and separate the metal fittings from the body of the car. This technique is being further investigated to see if it might have value in stripping unwanted material (rubber, upholstery, etc.) from abandoned automobiles prior to their disposal without utilizing incineration techniques. The technique might also be used to reduce the volume of bulky wastes.

A very special problem is now facing those in the Nation concerned with the disposal of solid wastes. This is the problem associated with packaging materials and disposable containers. The problem is really two-fold. First the increased use of this material in recent years has caused a significant increase in the volume of solid wastes that must be handled by the community and second, the nature of the disposable material is such that much of it is not amenable to decomposition and, therefore, presents special disposal problems. "Eternal" plastic and "unrustable" aluminum have made their way into solid waste technology and must be coped with if we are to effectively manage solid wastes.

A contract was awarded to study feasible methods of disposing of polyethylene plastic waste while another contract was awarded to the Midwest Research Institute to make a thorough study of packaging materials, trends in this industry and possible solutions which would be amenable to solid waste disposal without wrecking the industry. A part of this study includes the consideration of needed legislative programs to cope with this problem. I shall refrain from further comment on this subject since this Committee will hear from a representative of Midwest Research on this important problem. When this study is received it will be evaluated by our technical personnel and our future course of action determined.

The Solid Waste Disposal Act also directs the recovery and utilization of potential resources in solid wastes. Transformation of solid waste into a beneficial product has the advantage of disposing of a waste product, conservation of natural resources, and economic benefit which lowers the net cost of disposal. A Public Health Service research grant to the University of Florida is supporting development of a method to convert citric processing plant waste to citric acid. Another research grant to the University of Maryland is supporting investigation of the possibility of transforming wastes formed in the production, packaging, and canning of vegetables and cheese, to new foods or food additives.

The research staff of the Solid Wastes program has a section devoted to the development of new uses for solid wastes. One internal project is attempting to transform cellulose from solid waste into sugars. Another project stresses the possibility of chemical transformation of solid wastes into protein. Still another is attempting to transform waste rubber into useful new rubber materials by improvement of separation techniques and changing technology to allow a greater proportion of used rubber in new products. Other internal research studies are studying the recovery of useful inorganic and organic compounds from incineration residue, animal, and vegetable wastes.

One method of solid waste disposal resulting in a useful end product is composting. This method has received publicity during recent years—some good and some bad. Some plants were built to receive the municipal wastes of a municipality and closed their doors within a year while some have operated for years. We too wonder what the true story of composting as a solid waste disposal process in this country is. What are its technological requirements? What are it economic considerations? What is its likely future as a major method of disposal of solid waste? To answer these and other questions a study in depth of composting was undertaken jointly with the Tennessee Valley Authority. This Joint PHS–TVA Composting Project at Johnson City, Tennessee will evaluate composting of municipal solid waste as well as a mixture of municipal solid waste and sewage sludge. The plant has been completed and is now operating. Studies will be made to determine: (1) Potential agricultural use of the product; (2) The Marketing potential of the compost including geographic limits of the marketing area, and (3) Public Health hazards involved in the use of this product. Operating guidelines will be developed to assure maximum efficiency and plant environmental conditions will be evaluated. At the conclusion of this project the data gathered should permit a thorough and unbiased evaluation of this practice. The evaluation will include net cost figures and likely estimates of the market one might expect. There seems to be few neutral parties concerned with learning the whole story about this controversial method of solid waste disposal. We hope to shed much insight into this important matter.

The protection of the Nation's health is a primary responsibility of the Public Health Service. Consideration of the health hazards involved in solid waste management is no exception. The health hazards associated with air pollution from improper burning of solid wastes is well known as are the hazards from flies and rats which frequent open dumps and areas where improper collection and storage of solid waste is practiced. Not so well known, however, are health hazards involved in the collection of wastes. Those who perform this task are engaging in one of the most dangerous jobs in existence. Through the contract mechanism a study was made of the relationship between disease and solid waste. The research staff of the Solid Wastes Program are evaluating current solid waste handling practices and will evaluate new methods as they are developed to assure the public health is being properly protected as scientific technology advances.

Our research studies include investigation of the hazardous materials in refuse, pathogens associated with incineration processes and occupational hazards in solid waste handling. One might assume that the residue following incineration would be almost sterile. Preliminary investigation by our staff has discovered this is not necessarily true and surveys at several plants indicate gross contamination of this material with pathogenic organisms. Further investigation will determine the magnitude and applicability of this finding and hopefully develop an effective way of using this technique to determine the effectiveness of incinerator operation.

The studies of the occupational hazard of solid waste handling are being jointly undertaken by the research staffs at the Occupational Health Program and the Solid Wastes Program of the National Center for Urban and Industrial Health, and will be devoted to reducing the accident and disease rate by pointing out defects in present technology which contribute to these rates and develop technology which is both effective, economic, and safe.

The most advanced technology can be used to develop a magnificent incinerator or sanitary landfill or compost plant capable of doing the job economically and effectively, but if it isn't operated properly you haven't accomplished a thing. In our rapidly changing world great stress is placed upon new technology and scientific achievement many times of a very sophisticated nature but woefully little attention is given to teaching the man who must operate the facility how to run it and making sure he does a good job. New technology is needed in this area just as much as in those areas normally considered scientific. How do we assure proper operation of multi-million dollar structures?

The American Public Works Association is developing for the Public Health Service a comprehensive blueprint for the training of operating personnel in the field of solid waste disposal. This project supported by a Public Health Service contract will also identify and measure training needs to help guide those who will carry out such training. The technical staff of the Public Health Service's Solid Wastes Program are currently developing guidelines for the operation of sanitary landfills and incinerators using well known authorities in these areas as consultants. Both reports are due to be completed this year.

Perhaps the most difficult obstacle in getting new technology adopted and implemented is the reluctance of the public to accept solid waste disposal in the communities and the equally severe reluctance of communities to work cooperatively together to come up with one approach to solid waste management that is best for all the municipalities which make up a region or metropolitan area. People want their solid wastes problems solved but not near their home or near their community. Many small suburban communities know they could get by more economically by combining forces with others but many times prefer to go it alone to preserve their autonomy.

The Public Health Service through public information technology is trying to gain public recognition of the solid waste problems and gain public support for local solution to these problems. Certain demonstration projects such as the transformation of the Kenilworth dump to a model operation and land reclamation activity are designed to gain public support for proper solid waste management. A contract with the National Association of Counties is developing a program designed to educate public officials in solid waste needs, problems, and solutions.

Stimulating communities to work together on a regional or metropolitan basis is being approached by the Public Health Service's Solid Wastes Program through the mechanism of Study and Investigation grants to demonstrate how communities overcome the legal, interjurisdictional and public opinion difficulties in approaching their common solid waste problems on a regional basis. The regions being studied include metropolitan areas such as Louisville, Kentucky; Erie, Pennsylvania; New Orleans, Louisiana; Des Moines, Iowa; and Oklahoma City, Oklahoma. They also include entire counties such as Maricopa County, Arizona; Fresno County, California; Genesee County, Michigan; Jefferson County, Wisconsin; and Harrison County Mississippi. Low population density regional areas are included such as the area near Farmington, Connecticut and Great Falls, Montana. The studies also include special regional areas such as the Tocks Island Recreational Area encompassing part of three states, several economically depressed counties in Appalachia, and the Quad-City area in New Jersey. The results of these studies will bring to light approaches which can be used by other communities with similar problems and similar circumstances thus improving psychometric technology and providing answers which quite frankly have us and most of the country stymied at the present time.

Many problem areas have been pointed out and our approach to their better understanding and solution. I am confident methods will be found which will allow air and water pollution control criteria to be met—methods which are technologically sound, economically feasible, and safe from the standpoint of protection of the public health and our environment.

Lest my remarks here today be interpreted as a deterent to the use of current technology to solve existing solid waste management problems, let me set this issue straight right now. There are no legitimate reasons (except perhaps financial) to hold up the immediate elimination of open burning dumps, remodeling or replacement of antiquated incineration facilities without effective air pollution control devices, the abandonment of open broken-down collection vehicles which spew solid wastes along the route to the disposal site, and the cessation of feeding garbage to hogs. The Nation can improve its solid waste disposal practices and it can do it now. We have the technology to do it now—we are working to improve this technology and develop techniques which are not only more effective but are more economical. I feel personal sadness when I consider that the beautiful whooping crane is close to extinction and only heroic efforts have prevented it. On the other hand, I look forward with a great deal of zeal, enthusiasm, and pleasure when I consider one of the goals of the Solid Wastes Program—the elimination of the open burning dump from our society. This disgrace to humanity truly belongs to history not to our present and certainly not to our future.

In conclusion I would like to state that the Public Health Service is facing the Technological problems I have mentioned today with vigor and enthusiasm. Some of the approaches we are using will succeed and some will fail. We are confident, however, that their undertaking will furnish technological facts for more effective solid waste management and a better and cleaner America.

I appreciate the opportunity of discussing the solid waste management activities of the Public Health Service with you today.

Mr. **Daddario**. Will you proceed, Mr. Darnay?

Chairman **Miller**. May I ask a question?

Mr. **Daddario**. Yes, Mr. Chairman.

Chairman **Miller**. I am very much concerned with the disposal of waste. My city of Alameda used to open-burn, but the area air pollution board stopped us. The first thing the mayor did was to scream to high heaven that as the result of stopping this burning, we were going to have rats, but somehow or another we stopped the burning, improved the method of cover, and I do not think we have had so many rats. But this is not the point I want to get at.

How many disposable bottles from soft drinks and beer and other things are distributed today in this country?

Mr. **Vaughan**. I do not have that information, Mr. Miller but I think Mr. Darnay has.

Mr. **Darnay**. I believe I can answer that. Perhaps not on a day-by-day basis, but we have some data on the total.

Chairman **Miller**. If you have that in your paper——

Mr. **Darnay**. It is in my statement; yes, sir.

Chairman **Miller**. I had a discussion with a man when I was home this year about our own East Bay area in California. He is a distributor of beer. I said, "How many disposable bottles do you think you distribute a day?"

He said about 50,000. He is talking of a population area of a million and a half to two million people. I do not think that is too far out. It may be correct for beer, but how many bottles of Coca-Cola and Pepsi Cola and all of these other things that we now buy in disposable bottles, are there? How long will we find places to hide this material? If you have cellulose material or something of vegetable material, they will eventually disintegrate. A few archeologists 10,000 years from now will run across a mass of these bottles and wonder what they were used for. They may be here for 10,000 years. They still find the resin the Greeks were putting in their wines 5,000 years ago.

What are we going to do with this?

Mr. **Vaughan**. This is a very serious problem, and is one of the reasons we let a contract with Midwest Research to come up with some answers which will be reported on today.

Chairman **Miller**. It is more economical to use a disposable bottle because if you return the bottle, it has to be sterilized before it can be reused. So somebody is making a better profit by using so-called disposable bottles.

Should not perhaps the people share some of this profit with the Government to help dispose of the bottles they use? Should we put a tax on them?

Mr. **Davis**. Charge them a dumpage fee.

Chairman **Miller**. Some type of a fee, because the fellow is making money since he does not have to bring the bottles back and take care of them. It is cheaper for him to buy new bottles than to reuse them.

There was a time during World War II if you wanted to get a six-pack of Coca-Cola, you had to bring back six empty Coca-Cola bottles. Now you do not need bottles.

Mr. **Davis**. If the gentleman will yield very briefly, there is coming into government a concept known as a dumpage fee, which is beginning to apply to such things as air pollution and water pollution, which might well be applied to solid waste disposal.

Mr. **Vaughan**. This concept, I understand, is used now in the Ruhr River Basin in Germany. You pay on the basis of how much you use, or the magnitude of the problem your wastes might cause.

Mr. **Davis**. Yes.

Chairman **Miller**. I think this is one of the things that has to be looked at. Of course, I realize the bottle manufacturers will raise the dickens if you get into this dumpage fee, but why not face it squarely.

Mr. **Vaughan**. One of the more interesting statistics is that the per capita solid waste contribution in this country has doubled in the last 25 years, and to a large part, because of such problems as packaging material, disposable bottles, tin cans, and aluminum cans.

Mr. **Darnay**. May I comment on your question?

Chairman **Miller**. Yes.

Mr. **Darnay**. I believe the concept of a disposal fee that you mention is quite reasonable. Such a fee is one of the things we are going to recommend in our study to the solid waste program.

I ought to, also, at the same time, point out that industry is not alone in guilt in this entire question of disposable bottles. The American consumer likes to have a disposable type of container. As a consequence, even returnable type of bottles have been thrown away. We are a very affluent and hedonistic society, or at least we are becoming such a society. As a consequence, the penny-conscious youngsters are disappearing, and the housewife, on the other hand, does not wish to lug many different cartons of bottles back to the store. This is at the root of the popularity of nonreturnable containers.

Chairman **Miller**. I think this is very true and I accept it, but because my wife does not want to lug bottles back to the store, is that any reason why Mr. Carpenter, for example, should pay an increment of tax to take care of things she does not want to do, or other wives do not want to do? I think one way of measuring it would be to put the tax perhaps on the bottle, but it is not the fault entirely of the consumer. We like to get rid of bottles all right. But I think it is a new thing, this business of disposable bottles. It is going to give us one of the greatest headaches in the next 10 years that we are going to face.

Mr. **Daddario**. Mr. Darnay, do you presume in this recommendation that you may make, there will be a tax on people in industry, that they will pay a tax to a system which we will have developed to properly dispose of the material they are dumping. The fact remains at the moment, a lot of people are paying tax by paying the fine which comes about as a result of dumping materials into a dump or into a river, and yet the pollution problem is not in any way abated.

Mr. **Darnay**. That is true. The concept that we have developed would work somewhat like this: when you purchase color film, for instance, you purchase the processing of the film when you buy it. Conceivably, when you purchase a particular commodity, you could at the same time pay for the disposal of the packaging in which it comes. This would work best on a local level where the local conditions are known, let us say in a fairly large city or jurisdiction. The money collected on the containers could be routed directly to local disposal operators and could perhaps even pay for some of the innovations and some of the improvements that are necessary.

On the basis of our study, we developed a technique of ranking different materials or different containers to indicate their actual resistance to processing in different types of processes. If this ranking system were to be extended and refined, it could possibly become the basis for imposing a differential type of disposal fee, whereby paper containers perhaps would pay a lower fee than glass, metals or plastic, which are not as disposable.

This is a cumbersome type of approach because many decisions would have to be made as to what particular fee should be imposed on a particular container. But ultimately this would be in a way of recovering some of the disposal costs created by the containers without regulating the packaging industries, which would, in our opinion, be a much more cumbersome job.

Mr. **Daddario.** That assumes that you rate these in a graded pattern of some kind because you developed ways and means to dispose of them so they are not going to be harmful, and that is a big order, is it not?

Mr. **Darnay.** I believe we do have adequate means of disposing of our waste. Certainly packaging materials. Packaging materials are inorganic and as such they do not degrade. This is one of the problems involved with them. With the exception of some of the plastics, there are no real air pollution hazards associated with the burning of packaging materials as such. I believe a disposal fee could be imposed on the basis of present technology.

Chairman **Miller.** You might have a so-called tin can, or steel can coated with tin used for beer, as the original cans were. Now they are going to use aluminum cans, are they not?

Mr. **Darnay.** Yes, some.

Chairman **Miller.** Tin cans exposed to the weather would eventually disintegrate?

Mr. **Darnay.** That is correct.

Chairman **Miller.** Or with buried tin, there is moisture. How about the aluminum cans?

Mr. **Darnay.** Aluminum cans will be around for a long, long time. So will plastic containers of various types.

Chairman **Miller.** And so will glass containers. If you take a glass container and grind it down, it turns into sand, but the aluminum and plastic of course stay even if you were to reduce them.

Dr. **Hibbard.** May I comment on this particular point?

Chairman **Miller.** Yes.

Dr. **Hibbard.** Our analyses show that each ton of residue from municipal incinerators contains about 550 pounds of metal, about 500 pounds of which is iron and the rest consisting mainly of aluminum, copper, lead, tin, and zinc. In the Bureau of Mines, as part of our mission, we have been looking at the long-range need for these metals. We find that if the metal requirements are projected to 1985, or to the year 2000 in some cases, these very commodities we are throwing away today may be in seriously short supply.

For example, at this moment we are importing 40 percent of our iron ore. With respect to aluminum, we are importing 85 percent of its ore, bauxite. For each ton of refuse incinerated about 20 pounds of fly ash is generated and this contains gold and silver. Approximately 40 million troy ounces of silver are used every year for photographic purposes and a good part of this is just thrown away. We have found enough values in the fly ash from incinerators to be comparable to the assay of gold and silver in a normal mine out in the West. We think that the loss of these metals in municipal refuse is a very serious problem from a resource standpoint and that these solid wastes are a source of values that can help us to balance our supply-demand situation.

So we believe that aside from the pollution problem, we must develop the technology to recover and recycle every bit of these metals. And we think this is entirely possible.

For example, in our own State, Chairman Miller, we have been looking at the mill tailings on the mother lode around Grass Valley to see if we can make brick or stone or aggregate out of them. We found we are making gold bricks up there, for some of these tailings have values as high as $2 a cubic yard. This is well worth recovery.

So again, I think a key aspect of this problem is to make the economics as attractive as possible for gathering and reusing every bit of the values.

Chairman MILLER. I believe they are using tin cans now. They burn the tin off to process some of the tailings from the copper mines.

Dr. HIBBARD. Yes, they do.

Chairman MILLER. And they can reclaim copper cheaply and practically this way.

Mr. DAVIS. May I inquire as to a definition?

As an elementary chemistry student, I recall the definition of a solid was that which is distinguished from liquid or a gas. In this discussion of the solid waste disposal, is that the definition you gentlemen would use?

Mr. VAUGHAN. I think the act itself defines solid or solid waste by defining what comes under its jurisdiction. That is pretty broad.

Mr. DAVIS. I am not familiar with it. I am interested if it includes vegetable matter.

Mr. VAUGHAN. Yes, it does; all agricultural wastes.

Mr. DAVIS. It might be helpful to read that.

Dr. HIBBARD. It says:

> Garbage, refuse and other discarded solid materials, including solid waste materials resulting from industrial, commercial, and agricultural operations, and from community activities, but does not include solids or dissolved material in domestic sewage or other——

Mr. DAVIS. That would be, chemically speaking, liquid?

Mr. VAUGHAN. That is right.

Mr. DAVIS. Thank you.

Mr. DADDARIO. Proceed, Mr. Darnay.

(Mr. Darnay's biography follows:)

ARSEN J. DARNAY, JR.

Arsen J. Darnay joined Midwest Research Institute in mid-1965. His fields of primary specialization are market research, technological forecasting, and long range planning studies. Related special abilities include advertising research, public relations, and sales strategy planning. Mr. Darnay has done work in the international trade area, aided by specialized linguistic abilities.

Since joining Midwest Research Institute, Mr. Darnay has been project leader on a specialized short range techno-economic study project. The program calls for individual reports, issued in a series, dealing with technological and sociological subjects of near term significance. Studies on process control computerization, undersea technology, urban mass transit, medical electronics, water desalination, air and water pollution control, metal working, total energy systems, information retrieval, and educational technology have been issued.

Additional assignments have included research work on shipyard diversification, the dissemination of NASA generated technology to private industry, commercial construction forecasting, and the technological forecasting studies dealing with petroleum products and markets.

From 1961 to 1965, Mr. Darnay was a member of the embarketing staff of J. F. Pritchard & Company, an international process engineering and construction firm. He was responsible for promotion planning, market research, technical writing budget management, and public relations.

From 1956 to 1961, Mr. Darnay served in the United States Army as a Civil Affairs Specialist, Military Government Section, on the divisional level. Later he was assigned assistant to the commanding general of division artillery, involved in liaison work with the German community and German military forces in United States Army, Europe. He was decorated with the Commendation Ribbon for outstanding work.

Mr. Darnay attended Rockhurst College and the University of Maryland (overseas campus) where he studied history and economics.

Mr. Darnay is a member of the American Economic Association.

STATEMENT OF ARSEN J. DARNAY, JR., PROJECT LEADER, MIDWEST RESEARCH INSTITUTE, KANSAS CITY, MO.

Mr. DARNAY. Mr. Chairman and members of the subcommittee, my name is Arsen Darnay. I am a project leader with Midwest Research Institute. It is a pleasure to appear before you with this statement, which will outline in brief form the role packaging plays in solid waste.

Packaging and the solid waste problem are closely linked in the public view, and this with good reason. Discarded packages are visible all around us. It is impossible to take a stroll through city streets, drive in the country, walk in a park, or ride a boat on our rivers and lakes without encountering the tell-tale signatures of our affluence: discarded cans and bottles, cigarette packs and paper sacks, candy wrappers and similar objects. It is not surprising, therefore, that packaging materials are placed high on the list of items which create esthetic blight.

Until recently, no systematic analysis of the relationship between packaging and solid waste has been undertaken. About 9 months ago, a study was initiated at Midwest Research Institute, under contract to the Public Health Service, solid wastes program, to develop some clear-cut definitions of the role packaging plays in solid waste at the present—and will play in the year 1976. I directed that study, and this morning I should like to share some of our conclusions with you.

VARIOUS ASPECTS OF PACKAGING

Both packaging and solid waste disposal are complex activities. Consequently, the interaction of the two is difficult to discuss with precision. Packaging plays not one but several roles in waste disposal, depending on which part of the system we are looking at. One important overall observation, however, can be made. The aims of packaging and solid waste disposal are mutually exclusive, on the whole. The packager wants a container which will not burn, break, crush, degrade, or dissolve in water. The waste processor wants a package which is easy to reduce by burning, breaking, compaction, or degradation. More specific aspects of the relationship between packaging and solid waste disposal are these:

The sheer quantity of packaging wastes imposes a general load on the disposal facilities of the Nation. That is one aspect.

Collection of packaging materials is extremely costly if containers are thrown away carelessly, easy if they are discarded in waste cans.

Processing of packaging wastes may be easy or difficult depending on whether they are simply dumped or whether they are incinerated or landfilled. And different materials cause different degrees of difficulty.

Finally, reuse and recycling of packaging wastes presents yet another aspect, distinct from collection or disposal.

THE QUANTITATIVE ASPECT

First, let's look at the quantitative aspects of packaging. Forty-six million tons of packaging materials were produced and sold in the United States in 1966 (enclosure 1).

PACKING MATERIALS CONSUMPTION, 1966 AND 1976

[In millions of tons]

Material	1966		1976	
	Tonnage	Percent of total	Tonnage	Percent of total
Paper and paperboard	25.2	55	36.9	57
Glass	8.2	18	11.9	19
Metals	7.1	16	8.4	13
Wood	4.1	9	4.4	7
Plastics	1.0	2	2.5	4
Total	45.6	100	64.1	100

Source: Midwest Research Institute.

This massive tonnage—made up of many billions of individual units, most of them weighing much less than a pound each—represented about 12 percent of the 350 million tons of residential, commercial, and portions of industrial rubbish generated. This excludes agricultural manure, 1.3 billion tons yearly; mining wastes, 1 billion tons; scrapped automobiles, 6 million units or about 15 million tons, and building rubble, for which we have no estimate. The total comes to about 10 pounds per person per day, a figure roughly double the one you may have heard because it includes commercial rubbish and some industrial rubbish, not residential waste alone. Of this, packaging materials accounted for slightly over 1 pound per person per day.

Packaging materials tonnage will have grown to 64 million by 1976—up 18 million tons. This increase cannot be attributed to population growth alone. Americans will be using much more packaging in 1976 than 10 years earlier—122 pounds more, to be exact, for every man, woman, and child. Per capita package consumption will jump from 466 pounds to 588 pounds in the 10-year period.

Many factors underlie this dramatic increase, but chief among them is the continuing rise of self-service merchandising, which creates a growing need for packages which sell the product without the help of a sales clerk.

Mr. DADDARIO. Mr. Darnay, your statistics, I expect, assume the continued use of the type of packaging presently in existence and the growth of our population.

Mr. DARNAY. Yes, the basic assumption underlying this study is that the findings of this study, in themselves, will not be a factor in the forecast. We are assuming that the historical trends which presently exist will continue in force without interference.

Mr. DADDARIO. Have you, during the course of your studies, discussed with the packaging people ways and means through which the situation might be improved in one way or another, however that might be?

Mr. DARNAY. Yes, of course. That has come up in almost all of our interviews.

Mr. DADDARIO. Is there a possibility that these statistics might change with the development of different kinds of packaging? It could even take into consideration the development of a different mental approach on the part of the American people. Recognizing that this problem continues to grow in such proportions, somewhere along the line there needs to be developed a different way to handle it which would include psychological adjustments as well as the simple matter of disposal.

Mr. DARNAY. You are absolutely correct. Our study is a prediction of the type you might make about a danger. You make the prediction of the type you might make about a danger. You make the predictions in order to see the danger. Of course, you would modify your actions in accordance with your forecasts. If we were to do nothing about this general situation, we believe firmly that the findings would be as I have stated them in terms of tonnage.

Mr. DADDARIO. Do you include in that the fact that there needs to be adjustments of the kind I am discussing?

Mr. DARNAY. Yes, sir; the 18 million tons I referred to will have to be handled if we do not do anything. Needless to say, I believe we should do something.

PACKAGING AND WASTE COLLECTION

Collection of packaging wastes presents no special problems if the householder places rubbish in waste containers. The sheer quantitative increase in packaging, however, will put an added burden on waste collecting agencies by 1976. Just to haul the increase in packaging volume, waste collection trucks will have to make 4 million trips in 1976 which they didn't have to make in 1966. If new equipment has to be installed to transport the increase, expenditures exceeding $100 million would have to be made in the 10-year period.

PACKAGING AND LITTER

A much greater waste collection headache is presented by packaging materials carelessly flung from cars or left in our parks and along our rivers and lakes.

A vast difference in trouble and cost exists between collecting a ton of cigarette wrappers placed in cans and a ton thrown away thoughtlessly.

We were unable to ascertain just how much of the packaging material tonnage turns into litter—but we have found indication that well over half of the items in litter are packages or package components. This is on the basis of number of items rather than on pounds or tons.

In 1976, the litterbug will have considerably more ammunition at his disposal. Particularly noteworthy will be the greatly expanded use of beverage containers (enclosure 2). Disposable bottles and cans are expected to shoulder out the traditional deposit-type bottle.

BEVERAGE CONTAINER CONSUMPTION, 1966 AND 1976

[In billions of units]

	1966	1976
Total	30.5	62.9
Returnable glass	2.5	1.7
Nonreturnable glass	9.5	25.2
Metal cans	18.5	36.0
Beer containers	18.5	28.1
Glass	5.6	9.1
Metal	12.9	19.0
Soft drink containers	9.5	31.7
Glass	3.9	14.7
Metal	5.6	17.0
Liquor and wine (glass)	2.5	3.1

Source: Midwest Research Institute.

In 1966, eight beverage containers out of every 100 were returnable. Ten years later, only three out of 100 will be returnable. In the same period, per capita consumption of beverage containers will have shot up from 155 units in 1966 to 283 units in 1976; nearly a doubling of container use.

Unless an effective national conscience can be developed before then, the litter problem will have intensified as a result of this packaging development.

THE DISPOSABILITY OF PACKAGES

Once packaging materials have been collected, they must be processed. Just how disposable a package is depends on the package and on the disposal method. It is evident that a beer can is more difficult to handle in an incinerator than a paper sack. In a sanitary landfill, cans can be processed with somewhat less difficulty than paper.

As Mr. Vaughan has pointed out, the overwhelming bulk of our wastes—more than three-quarters—end up in open dumps. Wastes are simply deposited on soil. They may be burned to reduce their bulk, and thereby create air pollution. And that is all. Open dumping is not considered an acceptable disposal process, yet it is the dominant form disposal takes in our Nation. In this technique, the disposability of packaging materials cannot be measured. No processing takes place in any strict sense of the word, and package characteristics cannot be compared to process requirements.

In the two other major processes—sanitary landfilling and incineration—packaging materials appear to present relatively few difficulties to the waste processor.

One reason for this is that more than half of all packaging is paper, and paper is the most readily disposable of all packaging materials. The other major materials, arranged here in an ascending order of difficulty, are wood, plastics, metal, and glass. Metals and glass are roughly equal in terms of disposal difficulty.

In landfill operations, the greatest single difficulty presented by packaging materials is the resistence to degradation in the soil of certain materials. Aluminum, glass, and plastic containers are virtually indestructible and persist for decades and much longer. Even paper tends to have a long life underground. We have found some indication that paper has lived for about 60 years in the landfill and when extracted the text on it could still be read.

In incinerators, metals and glass show up as inert residue—which must be hauled away. Plastics can cause trouble when they appear in high concentrations. This can occur when industrial discards, high in plastics content, must be handled. Packaging materials do not yet contain sufficiently high percentages of these materials to disrupt operations consistently; nor will they appear in high enough concentration by the mid-1970's.

By 1976, the relative difficulties of processing packaging wastes will have increased somewhat. But this will be due to the fact that many open dumps will have been shut down—replaced by sanitary landfills and incinerators in which much more material processing has to take place. The relative dominance of materials will remain about the same. Paper will still be in the lead and will, in fact, have enlarged its share of total packaging. Plastics will have doubled in tonnage; but in 1976, they will amount to only one-fourteenth the size of paper.

REUSE OF PACKAGING MATERIALS

In an ideal system, packaging materials would never be discarded—they would be reprocessed by industry and made into new packages or other products.

We are very far from such a situation today. Of the 46 million tons of packaging materials produced in 1966, only about 4.5 million tons were recovered—mostly old corrugated boxes and returnable glass containers.*

Once packaging materials have passed through the gamut of the trash barrel and the compactor truck, they are hopelessly contaminated with organic matter, dirt, and moisture and intimately mixed with other wastes. It would be virtually impossible to separate them economically from the trash even if they were clean. The result is that we squander billions of dollars worth of materials every year—valuable fibers, metals, plastics, and glass. In 1966, materials worth $16 million were converted into packages. This will give you an idea of the value thrown away.

This situation might be improved slightly if packaging wastes could be separated before disposal. But the American homemaker has a marked distaste for separating waste materials. On the other hand, she is an eager buyer of "disposable" packaging. Monumental efforts at public education would be required to bring about a change in her attitude in a period of relative national security and prosperity. Even if she could be persuaded to separate her wastes into bins labelled steel, aluminum, plastics, paper, glass, and so forth, her efforts would only ease the problem.

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*Recovered packaging materials are made up of 2.5 million tons of old corrugated boxes, 1.1 million tons of returnable glass containers, and 900,000 tons of all other materials.

The reason is that the aims of the package manufacturer and the conservationist not only fail to coincide but conflict. The purposes of conservation would be served best by packages which are homogeneous in composition and relatively uniform in size and shape. The evolution of packaging is in the direction of more types of packages and more combinations of dissimilar materials.

Relatively few packages are "pure" in the sense that they are made of a single material. Steel cans contain tin, lead, organic adhesives, and are overwrapped with paper. Some glass bottles come with twist-off caps that leave a ring of aluminum adhering to the bottle neck. Steel bottle caps are commonly gasketed with plastic or cork. Paper is laminated to metal; coated with clay, plastics, or wax; fastened with organic glues or steel staples; printed with a variety of inks. Plastics are combined with paper or laminated with other plastics and sealed with steel or aluminum closures.

The various technologies to process such compound materials are nonexistent. At the same time, highly advanced systems for the conversion of virgin materials have evolved over time. Not surprisingly, contaminated packaging wastes are not viewed as an economical resource by industry.

Relative abundance of raw materials—expected to continue for at least the next 10 to 15 years—makes it seem unlikely that salvage technology will make any rapid strides in the near future.

By the turn of the century, at least some categories of waste materials may be economically recovered in substantial quantities. By that time, our demand for paper is expected to outstrip our capacity to produce pulpwood, in the view of some observers. Such a situation need not produce a crisis if we develop economic means of recovering our waste materials. Each ton of recycled wastepaper saves 17 pulp trees. There is need, however, to ready a technology to make recycling feasible before the necessity for it becomes urgent. Since few corporations using waste materials plan more than 5 years into the future, the Federal Government should assume leadership in this area.

RESEARCH NEEDS

Research in five areas seems to be called for to forestall future problems:

1. Automation of waste collection;
2. Separation of refuse into its components;
3. Refining of heterogenous waste masses;
4. Development of secondary uses for wastes; and
5. Improvement of salvage operations to promote waste material use.

Our waste collection practice today is analagous to water distribution practice on the American frontier in the early parts of the 19th century. Waste collection remains the last residential utility which is not automated. In part this may always remain so. A high proportion of residential wastes, however, and most of the packaging materials which reach the home, could be conveyed to central facilities by pipe following some form of waste reduction. Automation could substantially reduce the costs of collection: gathering and transport of wastes absorb approximately 90 percent of all expenditures on waste handling today, or about $3 billion, and the bulk of collection outlays are in the form of labor costs.

Separation of wastes by type cannot be accomplished without manual labor. Innovative techniques of sensing materials and separating them by materials handling equipment are needed. Such hardware, once developed, might be too costly for today's use; but without such equipment, a major problem of future waste reuse would remain unresolved.

Suitable technology should be developed for refining heterogenous "waste refinery" by pipe. Such a technology might encompass chemical refining and extraction, mechanical separation, magnetic removal, mechanical sorting, et cetera. Our ingenuity in the processing of virgin materials would indicate that such a technology is within our reach.

Research should be intensified for secondary use of wastes—waste combustion to generate electricity, production of soil conditioners, use of selected waste components as substrates for animal feed production, conversion of wastes into building products, and the like.

Most urgent is the need to work closely with the packaging industries to increase the quantity of waste materials they recycle. This could involve such moves as elimination of tin from steel cans substitution of new paper coatings for those which create difficulties in the repulping of these fibers, elimination of inks which resist de-inking or improvement of de-inking processes. All of these steps would require much work and would be far from easy to accomplish.

Work to improve the technology of salvage would also pay dividends in the long run. Most needed are new techniques of pelletizing, shearing, baling, compressing, and sorting of scrap materials.

Finally, and this lies beyond the strictly technological scope, sufficient economic incentives should be created to tap industrial talents for the accomplishment of the tasks enumerated above.

Waste disposal, including waste reuse, is an area we have largely ignored. Only recently have we come to recognize the existence of problems connected with large accumulations of waste resulting from affluence and urban congestion. The genius of our Nation has not yet been aroused to deal with this problem. When it is, solid wastes—and particularly packaging wastes—may be transformed into a national asset.

That, Mr. Chairman, concludes my statement.

Mr. DADDARIO. As the result of your study, what would you deem to be sufficient to tap industrial talents?

What are you talking about?

Mr. DARNAY. Specifically, it might be an investment tax credit that would be applicable to machinery to handle or process wastes. For instance, de-inking type plants, which make it possible to recycle more wastepaper, or pelletizing machines to reduce paper into pellets, or scrap handling machinery in general. Or if we were to use disposal fee, a disposal fee system could serve to create incentives by permitting a lower fee to be charged on a particular package that is more disposable.

For instance, a tinless steel can could be assigned a lower fee because it would be possible to recycle it to the steel industry.

Mr. DADDARIO. Are there any questions, gentlemen?

Mr. MILLER. No. I want to congratulate Mr. Darnay. I think it is a very fine paper. It lays out some of the problems.

Mr. DADDARIO. Mr. Davis?

Mr. DAVIS. Yes, I have a brief question. We have one more witness, do we not, Mr. Chairman? I will make my question as brief as possible and I would like to address it, if I may, to the whole table.

It seems to me there has been too little emphasis placed on the social lag, may I say, or maybe the political lag, of our governmental structures as to dealing with waste disposal.

My own experience has included a great deal of problems in that connection. I was formerly a judge of a court in the northwest corner of Georgia. One of the edges of my circuit was the Tennessee line, the other was the Alabama line. We have a great deal of outpouring of citizens, I should say, from the city of Chattanooga and part of my present congressional district. We had a great problem with garbage disposal. Our governmental structure just was not competent to deal with it. We did not have a municipal government in many areas where the problem assailed us. We had garbage dumps that just materialized out of nowhere.

We did not have a garbage collection system. We had a law against dumping garbage, but you cannot catch them. It is sort of like trying to catch an arsonist, it is almost impossible. It seems that one of the major problems in this whole area of inquiry is that of getting social acceptance of the size of the problem. I think maybe you gentlemen may not have emphasized that enough. I think it is something that we have to sell to the public. I think we have to generate a sense of social responsibility that will cause people to realize, not only the corporations, but the individual citizens that that is part of their responsibility, to bear the cost of disposing of their garbage.

Mr. VAUGHN. Mr. Davis, I could not agree with you more. I assure you that the problem of garbage disposal is not just restricted to Georgia and Alabama. It is applicable to the whole United States.

This is one reason why we have studies and investigations to try to show people various methods in which they can work together across State boundaries or other governmental or jurisdictional boundaries to get the job done. We have to show people what good practices are, so that they will realize that much more needs to be done in their own communities.

Mr. DAVIS. Thank you, Mr. Chairman.

Mr. DADDARIO. Mr. Brown.

Mr. BROWN. I have no questions, but I would just comment that this table on page 6 gives the answer to Mr. Miller's original question about the number of bottles. It looks like one bottle per week per person; if you have a hundred thousand people that is a hundred thousand bottles per week.

Mr. DARNAY. May I comment on that?

Mr. DADDARIO. Yes, sir.

Mr. **Darnay.** This table might be slightly misleading. It shows beverage containers that are produced. It does not necessarily show all the beverage containers that are in circulation. In 1966 there were about 68 billion beverage containers in existence. In 1976 the figure will be 82 billion. The returnables are cycled back and forth and as a consequence they do not show up in exactly the same ratio as they exist. But about 2.5 billion were made in the year 1966. I think that might clarify some of the figures.

Mr. **Davis.** Mr. Chairman, may I add one more comment to what I have said? We have a saying back home if you want to get along with somebody, keep your hands off his wife and his pocketbook.

I believe this gentleman made the statement a while ago that there seems to be an inclination on the part of some small communities to go it alone and not to adopt a regional aspect.

I am familiar with that. The reason for that is you are trying to get your hands on a man's pocketbook when you tell him he has to pay more money for garbage collection. That is implicit in all of these annexation problems we have.

For example, in the south end of my district, if you will forgive me for keeping on referring to my own problems, we have what we call the Stop Atlanta Movement, which is on the south end. It is just a question of a man's pocketbook. It costs more money to have garbage picked up, or solid waste disposed of, if you want to phrase it that way. That is just one of the human aspects of the problem that has to be conquered. It is just a matter of enlightenment as one way of looking at it.

Mr. **Daddario.** I think Mr. Davis has added something to this discussion which is necessary, because he has been touching on the development of consciousness on the part of people as well as the development of a national conscience. When we were developing our report on the adequacy of technology for pollution abatement, and went into this question of solid waste, we had a key phrase which calls to mind the importance of that. I will just quote it because I think it fits exactly in here. It is "Whether the intrusion of Washington will engender a permanent increase in local consciousness and conscience remains to be demonstrated." That is really the job of you people who have been charged with this to develop the answer to that particular proposition that we proposed prior to the passage of this legislation.

Mr. **Miller.** If I may make this comment: I do not think it is such an impossible thing.

It was not so long ago that out in our part of the country we did not take air pollution very seriously. In about a decade we have become pretty well conscious of it. I think in a decade you could do a lot to educate people in this field.

Mr. **Daddario.** I do not assume, Mr. Chairman, that it is impossible, but I do think it is important to stress the point Mr. Davis raised, because it appeared to this committee at the time we made this investigation that this was one of the great problems.

In order to be able to achieve a favorable situation so that this does not become an impossible task we must develop a consciousness on the part of the people.

Dr. Hibbard.

Dr. HIBBARD. Shall I go ahead?

Mr. DADDARIO. Please.

Dr. HIBBARD. If I may, Mr. Chairman, I would like your permission to insert my statement in the record and then to summarize it.

Mr. DADDARIO. We will put the whole statement in the record. We will allow you to summarize it and give you a chance to go over your extemporaneous remarks.

STATEMENT OF DR. WALTER R. HIBBARD, DIRECTOR, BUREAU OF MINES, DEPARTMENT OF THE INTERIOR

Dr. HIBBARD. The statement includes the source of our authority, a review of our cooperative activities with the Public Health Service, and a discussion of our concentration on three areas, municipal wastes, tailings, and scrap. I want to emphasize that our efforts are aimed at recovering the metal and mineral values from solid wastes, and in particular finding ways and means of disposing of the solid wastes that are generated by the extraction, processing, and utilization of minerals and mineral fuels.

As I mentioned before, the problems confronting the Nation with respect to mineral supply are such that in the mining industry there has been a tendency to rework the tailings or waste materials wherever values have been found in them.

For example, in the Salt Lake City area a large corporation is processing their old waste materials and finding values in them which make it profitable to retreat them. We believe that one of the ways of disposing of these materials is to determine the values in them and to identify the technology so that the normal process of our economy will move the activity to industrial realization.

If this does not succeed the next step is to find out ways and means of disposing of them or covering them by seeding and fertilization so that they will not be an eyesore. With respect to the municipal wastes, again, we believe there are values here. We have been working with Montgomery County officials in the collection of residues from the county incinerator in order to find ways and means of treating this material for metal and mineral recovery.

We find that there are values here, in many cases comparable to ores found in the West but the major problem is collection and transportation. Here again, the minerals industry has had experience with pipeline transportation of coal and other materials as slurries or through pneumatic techniques and I believe technology is available to do this kind of thing provided the economics can be worked out.

Mr. DADDARIO. Would you go into that? You just said provided the economics can be worked out. That follows your emphasis on the reuse or recycling. The development of a potential leads to the key that there needs to be an economic value. What is the hope that this can be done?

You talk about gold and silver, and what not? I understand Eastman Kodak, as an example, has thrown away a lot of its material. From what I understand, it seems that they have not been able, even though they know there is a lot of material in that refuse, to economically take it out.

What you say is so, if it could be done it would alleviate our problems. What is the chance of such a return so that it will be economically feasible?

Dr. HIBBARD. We must try to predesign our processes for producing automobiles and other products to enhance their recycle value. We must apply the total systems concept to the use and reuse of our entire supply of minerals.

Many scrap materials from obsolete automobiles contain metal values in combinations, both mechanical and chemical, that are not normally encountered by the extractive metallurgist. Vast tonnages of pure metals and alloys are trapped in manufactured products. The profusion of copper wiring locked between panels in automobiles and electrical appliances is an example. Many of the ever-increasing variety of alloys returning as scrap continue to accumulate in junk piles for want of extractive methods for separating and reclaiming the metals they contain. This problem is compounded by the fact that many of these alloys—some containing metals in critical supply—were developed to resist just such conditions as are used by the extractive metallurgist for making separations. That is, they are extremely refractory and corrosion resistant to most chemicals. New technology must supply answers to these problems, and show the way to recovering these natural resources and returning them to our economy. The reuse of these resources would be advanced by properly designing systems which will (1) extend the life of our products; (2) assist in ease of maintenance and repair; and (3) simplify the salvage of metals.

With respect to the gold and silver in the flyash from an incinerator, this ash is a solid particulate matter normally removed by a precipitate, or other techniques, from the incinerators' stack gases.

The values per ton in this flyash are equivalent to mineable values in the West.

If one could find a way of collecting this flyash, either by a pneumatic or slurry technique, or getting it concentrated in some other manner, the material would be well worth shipping to a smelter for recovery of gold and silver.

Mr. DADDARIO. You are working on this.

Dr. HIBBARD. Yes, sir. We have been in contact with the New York City government, and we believe that they have enough incinerators to supply an adequate quantity of material to make metal recovery economically feasible.

Mr. DADDARIO. Who else in government, just from the standpoint of how this is working out, is working on this same kind of a proposition, the economic feasibility requirement being so important? How are you working together? What is the size and scope of the whole proposition?

Dr. HIBBARD. The Public Health Service is working on municipal refuse as well, and we are cooperating with them. We have a memorandum of understanding of areas in which we are going to work in and techniques by which we will keep each other informed. I think this cooperative effort worked out extremely well.

Mr. DADDARIO. You are working together or separately on the same proposal letting each know what you are doing?

Dr. Hibbard. The area of Bureau of Mines activity is in those solid wastes which are generated by the extraction, processing or utilization of minerals, and mineral materials. Where there is an overlap, for example, in the case of the incinerator, we are not concerned with incineration per se. In working with Montgomery County our only interest is collecting what comes out at the bottom of the incinerator and seeing if this can be treated as a source of metals. Through this coordination we are not duplicating efforts and we are keeping each other informed. We each have an area of responsibility where we are putting forth our efforts.

Mr. Daddario. Could we get a copy of that memorandum of agreement?

Dr. Hibbard. Yes, sir.

Mr. Daddario. We appreciate having it for the record.

(The memorandum follows:)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
Washington, D.C., June 3, 1966.

Mr. WALTER R. HIBBARD, Jr.
Director, Bureau of Mines,
Department of the Interior,
Washington, D.C.

DEAR MR. HIBBARD: There is attached an original and 2 copies of the Memorandum of Understanding between your agency and the Public Health Service defining the principal areas of program interest of our respective agencies and establishing mutually acceptable working relationships for programs under the Solid Waste Disposal Act of 1965, P.L. 89–272. After signature for the Bureau of Mines, please return the original to me, retaining the signed copy for your office.

Since Mr. Wesley E. Gilbertson is responsible for solid waste disposal activities with the Public Health Service, I have designated him as the principal official to work with your agency on program matters relating to P.L. 89–272.

Sincerely yours,

WILLIAM H. STEWART,
Surgeon General.

MEMORANDUM OF UNDERSTANDING, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, AND THE DEPARTMENT OF THE INTERIOR, BUREAU OF MINES

Relative to Implementation of Title II, the Solid Waste Disposal Act of 1965, Public Law 89–272

The Department of Health, Education, and Welfare, Public Health Service, and the Department of the Interior, Bureau of Mines, each has an area of responsibility for implementing the provisions of Public Law 89–272, the Solid Waste Disposal Act, and are mutually desirous of developing a coordinated program toward the attainment of common objectives under the Act. The report of the House Committee on Interstate and Foreign Commerce (Report No. 899, Page 27, lines 19 through 36), states that, under the provisions of the bill, subsequently enacted as Public Law 89–272, the Department of Health, Education, and Welfare "would be responsible for administration of the Act, except that the Secretary of the Interior will be responsible for 'solid waste resulting from the extraction, processing or utilization of minerals and fossil fuels where the generation, production, or reuse of such wastes is or may be controlled within the extraction, processing or utilization facility or facilities and where such control is a feature of the technology or economy of the operation of such facility or facilities.' This arrangement would make the Secretary of Health, Education, and Welfare responsible for administration of the Act with respect to solid waste problems of communities, including those problems which may affect the general environments of communities, and including those solid wastes or solid waste residues that result from business and industrial activities and become part of the community's solid waste disposal system. The Department of the Interior, as above indicated, would be responsible for solving industrial solid waste problems within facilities engaged in extraction, processing, or utilization of minerals and fossil fuels in the circumstances above defined." To accomplish these objectives, the Public Health Service and the Bureau of Mines have entered into this Memorandum of Understanding in order to define and describe the principal areas of program interest of each agency and to clearly establish a mutually acceptable working relationship which insures proper coordination of all programs under Public Law 89–272.

It is mutually agreed that:

A. The Public Health Service and the Bureau of Mines will designate officials to act as the principal contacts and liaison officers at the program level in interagency matters pertaining to Public Law 89–272.

B. In regard to demonstration grant applications under Section 204 of Public Law 89–272, the Public Health Service will refer to the Bureau of Mines for necessary action, those demonstration grant applications pertaining primarily to mineral of fossil fuel solid waste problems as defined under Section 203(1) of the Act; and the Bureau of Mines will refer to the Public Health Service for necessary action those demonstration grant applications pertaining to other solid waste problems.

C. The Public Health Service will refer to the Bureau of Mines for review and comment those demonstration grant applications which give major emphasis to components involving mineral, metal, and fossil fuel solid waste problems as part of a broader solid waste disposal program; and the Bureau of Mines will refer to the Public Health Service for review and comment those demonstration grant applications in which the mineral and fossil fuel solid waste problems have significant community implications. In the above cases, it is understood that any comments the reviewing agency wishes to make will be forwarded within a period of fifteen (15) working days from the time of receipt.

D. The Bureau of Mines and the Public Health Service may support, on a joint basis, demonstrations, research, or training projects which have implications for disposal of solid wastes from minerals or fossil fuels and from community sources.

E. The Public Health Service and the Bureau of Mines will perform reimbursable services for each other, when such action is appropriate and feasible and mutually beneficial to the agencies.

F. The Public Health Service and the Bureau of Mines will exchange information regarding program activities under Public Law 89–272. This will include information on grant awards and similar actions.

G. The Public Health Service in carrying out its responsibilities for developing comprehensive State and local solid waste programs, and in providing technical assistance to State and local agencies and industry, will need technical information from the Bureau of Mines. From time to time such information will be made available by the Bureau of Mines to the Public Health Service.

H. Since the processing and disposal of automobile and other metallic scrap involve problems of community environmental pollution, blight, and parallel resource problems in the technology of salvage and utilization, the Public Health Service and the Bureau of Mines may jointly conduct projects on broad phases of the junk and scrap auto problem, and individually on specific appropriate complementary segments.

This Memorandum of Understanding shall become effective upon acceptance of both parties, and shall continue indefinitely, but may be modified at the request of either of the cooperative agencies. This agreement may be terminated by either agency upon thirty (30) days notice in writing.

DEPARTMENT OF THE INTERIOR,
BUREAU OF MINES,
(S) WALTER R. HIBBARD, JR., *Director*.

JUNE 7, 1966.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
PUBLIC HEALTH SERVICE,
(S) WILLIAM H. STEWART, *Surgeon General*.

JUNE 3, 1966.

Dr. HIBBARD. The second part of this problem, assuming that it is not going to be economically feasible to do this on a straight profit venture, is to use the same technology to minimize the cost of the disposal as small as possible.

So there are two possible uses of this technology.

Mr. **Daddario.** Then you get into subsidizing the removal of garbage and other solid wastes.

Dr. **Hibbard.** It is going to cost a certain amount of money to dispose of municipal refuse and if we can minimize that cost through the recovery process, this will be helpful. The second angle is that we do need these metals, and we are going to need them more and more as time goes on.

I have had the opportunity to spend some time around the country this year lecturing in various areas where we have research centers, and I have pointed out to the housewife that when she takes a piece of aluminum foil and bakes a potato in it and throws it away, she is throwing away a valuable metal. Because we are importing 85 percent of our aluminum needs, the recovery from municipal refuse will benefit our total economic situation. I believe that the public can become responsive to this and I believe that if they see that this issue is important to the country and that they can contribute to it, they will respond to it.

May I continue? In the scrap area, there is in existence a going industry which does reprocess scrap. Between 25 and 50 percent of our metals are recycled annually. Nevertheless, there is still a large amount of material that is not recycled. This is, in fact, the material which is difficult to separate. Part of our program is working on ways and means of helping with this separation. As I mentioned the silver waste in fixer and photographic materials is very valuable and the major photographic companies have programs for collecting spent fixer and recycling the silver.

We believe this can be improved through a public awareness of the need for such activity.

With respect to automobile scrap and refrigerator scrap, there is a very large inventory of iron and steel in this form, and it is, I think, absolutely essential that we find economically feasible ways to use this scrap from the standpoint of our natural resource requirements.

I have here a list of our existing projects. If I may I submit this to the staff. I do not know whether you want it in the record or not.

Mr. **Daddario.** Thank you, Dr. Hibbard, if you would give it to the staff.

(The information referred to may be found in the committee files.)

Dr. **Hibbard.** In conclusion, we are continuing our programs both in-house and contract, and our joint venture research with industry in an effort to solve these problems in the most effective way.

We believe that much of the required technology already exists.

The major problem is economics. I suspect this will require additional technology before it can be solved.

Mr. **Daddario.** Mr. Vaughan, do you have anything to add to the question of economic feasibility and the work that is going on in developing the necessary techniques?

Mr. **Vaughan.** I do not have anything to add.

I agree with Dr. Hibbard that we have the technology to do the job now. One of our major needs is for more widely applied economic technology.

Mr. DADDARIO. What is your feeling about this relationship you have developed where you are both working on this problem? Is it a proper relationship, is it a sensible one?

Mr. VAUGHAN. I think it is a proper one, yes. I hope we can make it even more so. I am fairly new to the job. It is my intention to make it even more profitable.

Mr. DADDARIO. I wonder if we might have, since we do have the memorandum of agreement in the record, a breakdown of the people who are involved with it in both areas and just how the liaison is set up through a committee or otherwise?

Dr. HIBBARD. This information is in the agreement.

Mr. DAVIS. If I may ask one more question. Maybe this is Mr. Vaughan's question. In the question of composts, is that limited to vegetable wastes?

Mr. VAUGHAN. No.

Mr. DAVIS. Is it possible to compost paper products, for example?

Mr. VAUGHAN. Some, yes.

Mr. DAVIS. It is pretty slow, is it not?

Mr. VAUGHAN. Yes, it is. The cardboard boxes are more difficult, but paper can be ground up.

Mr. DAVIS. Is it slower than wood would be?

Mr. VAUGHAN. No; it is not as slow as wood would be.

The process consists of separating bulky items that cannot be composted or are difficult to compost such as plastics and large cardboard boxes.

Mr. DAVIS. How long would it take to compost a pasteboard box?

Mr. VAUGHAN. I cannot give you an exact estimate but I would say approximately a couple of months.

Mr. DAVIS. That is not too long.

Mr. VAUGHAN. No. It depends on its size and thickness and also on the effectiveness of the grinding mechanism. One of the most important things in composting, after separation of the unwanted material, is through grinding and moisture control. You must keep it moist and stir it up. From that point, some people put it into a tank and add air to it to accelerate the compost. Others let nature do this by putting it out in windows, keeping the moisture content proper, and turning it over from time to time to make sure it has enough oxygen so it won't smell. This changes it into humus material, which is not a fertilizer but can be used as a soil conditioner.

Mr. DAVIS. Or as a mulch.

Mr. VAUGHAN. Yes. The final processing, maybe 2 or 3 weeks later, is grinding to a desirable consistency for application.

Mr. DAVIS. Would you consider that such things as insecticides, DDT, and things of that kind might enter into the effectiveness of composting?

Mr. VAUGHAN. If the volume of insecticides that got mixed in the wastes, were big enough, it could interfere with the bacterial action that takes place. From a practical standpoint, I doubt if this would occur unless you had a very unusual situation. There are some areas where the contribution of this type of waste to the percentage of the solid waste is very high.

Mr. DAVIS. Thank you.

Mr. DADDARIO. Dr. MacKenzie, I have a question I would like to ask you about in this area of recycling. Does the Public Health Service, because it has such a heavy requirement in the area of health, and because of the emphasis that needs to be placed on it, find itself inhibited in any way in doing research in recycling, which seems to be a part of this particular problem? Because you have necessary mission emphasis, do you find it more important to solve these problems than to have heavy research work which needs to be done in the recycling area?

Dr. MACKENZIE. I think I can only answer this in general terms, Mr. Chairman. The importance of recycling has appeared obvious to all technical people who have examined the problems of waste management. It is particularly true in my view in the water field and in the solid wastes field. We have special interests in relation to recycling in connection with possible buildup of residues that may build up in a recycling process and might affect health. This in no way limits our interest in recycling as a method or as a procedure which should be fully evaluated. It merely throws in a cautionary element to which we must give particular attention.

Mr. DADDARIO. Could you emphasize the precautionary elements?

Dr. MACKENZIE. For example, there is a great deal of talk about recycling water for reuse. In some of the processes that are under consideration, there is associated buildup of, let us say, dissolved materials in the water, unless one is using a distallation technique which can effectively remove these.

We must look at the buildup of such dissolved materials in the water as this might have physiologic or toxic effects, particularly if water is going to be used for household or drinking purposes. This does not mean that we are against reuse, and I want to emphasize this, because one of the major ways of reducing water pollution obviously for many years has been to attempt to "bottle up" the waste material by recycling the water in industrial processes. This is an accepted method and one which should be highly encouraged for use now and further development. I see no conflict, Mr. Daddario, in these objectives if one looks at the total picture and takes into account the limitations that might be imposed under a particular circumstance.

Mr. DADDARIO. From the standpoint of the way in which we are handling the research activities in all of this, are you satisfied—recognizing that we have not gone very far since the legislation has been passed to allow full development to take place—are you satisfied with the structure that exists in order to attack this problem? Or would we be getting at it more quickly if we were to put all of the responsibility in one place?

Dr. MACKENZIE. I think we have a variety of organizational structures in the waste management field on the Federal level, sir.

Mr. DADDARIO. It is this variety which causes us so much concern.

Dr. MACKENZIE. I can understand this concern. I do not have any panacea that would solve this, or any pat solution for it. I think there are a variety of ways in which these activities can be organized. I think the important consideration is that there not be undue duplication and that there be full coverage of what needs to be done.

Within this overall concept, I think there are several ways in which each of the components of the problems and the activities associated with them can be organized.

Fundamentally, I lean toward the concept of a designated agency to have prime responsibility in an area of operation. I think fundamentally this perhaps is the soundest approach from a management point.

Although this may be the best theoretically, I think we must still deal with the practicalities of the way the Federal Government is currently organized in the departments and agencies, and the locations in which there is expert competence to deal with the problems that are involved.

If one takes, for example, the matter of the health interests in some of these elements, in my view the Public Health Service has background, competence and facilities on which the health component of the activities to be undertaken can best be built. This competence could be used in various ways.

For example, rather than having the entire activity in the Public Health Service on this account, one might also incorporate this competence by detail of personnel to other agencies. Basically, I think one must tailor the organization to the job that needs to be done, and take into account the capabilities that exist in the organizations as they are now set up in the Federal Government, in the executive branch. I think there is going to be a continuing problem, Mr. Chairman, as we go down the pike in all of these waste management fields, to organize our activities in the best way, so that we can accomplish the objective that is desired most economically and most effectively.

While there are general principles that attach to organizing these activities I think we must tailor them individually at various times with the realities of the existing situation firmly in mind.

I realize that I am not fully responsive or offering you a general solution here, but I do not think it is feasible to do so.

Mr. DADDARIO. You are as responsive as you think you can be under the circumstances, and I think responsibly responsive, because this is a problem which we do run into from time to time.

Our concern is that at this stage of the game when we find ourselves with public support to accomplish objectives in this whole area, and also in a time of budgetary restraint, that it becomes incumbent upon us to be more proficient in the accomplishment of research and management techniques than we have been in the past.

The one thing I do find in these last several years, where agencies would fight to the end in order to maintain the integrity of their inhouse competence, so to speak, that there is developing a philosophy somewhat similar to the one you have propounded here. There is not so much of a fight to maintain jurisdiction which in many cases, artificial as it was, in fact did hurt the progress of the work. I am heartened by what you said. I think it will be helpful to us. One of the objectives of this committee in these hearings is to develop an attitude about the way in which these things are in fact being managed.

Dr. MACKENZIE. I appreciate your interest in this matter because it is an important one.

Mr. DADDARIO. I appreciate what you have said. It is extremely helpful. We want to thank all of the witnesses here this morning.

I regret that we had to call you on a Friday, but it was necessary this week.

(Dr. Hibbard's prepared statement follows:)

PREPARED STATEMENT OF WALTER R. HIBBARD, DIRECTOR, BUREAU OF MINES, DEPARTMENT OF THE INTERIOR

Mr. Chairman and members of the Subcommittee on Science, Research, and Development:

I appreciate the opportunity to appear before you today and to discuss the programs and activities of the Bureau of Mines relating to Solid Waste Disposal. Our research in this important area was initiated under the authority of Public Law 89–272, The Solid Waste Disposal Act. One of the purposes of this Act was to—

"initiate and accelerate a national research and development program for new and improved methods of proper and economic solid waste disposal, including studies directed toward the conservation of natural resources by reducing the amount of waste and unsalvageable materials and by recovery and utilization of potential resources in solid wastes."

Authority for the work rests with both the Department of the Interior and the Department of Health, Education, and Welfare. To make sure that the problem areas were fully covered and to prevent duplication of research, a letter of agreement was drawn up between the two agencies in which the responsibilities of each were clearly defined.

Following passage of the Act, the Bureau of Mines organized a research program directed toward solving the problems involved in utilizing or disposing of the enormous quantities of solid wastes generated in mining and in the mineral and metal processing industries. As a first step a survey was initiated to appraise the magnitude and nature of solid wastes accumulated to date with emphasis on delineating those waste piles which pose the greatest threat to the quality of the environment. Concurrently, investigations were started on the problems that appeared to be the most urgent. A program of contract and grant research also was organized to supplement the Bureau's own work and to aid in the training of engineers and scientists in the field of solid waste research. The total research program covers three major categories: munipical wastes, tailings, and scrap.

MUNICIPAL WASTES

Although the overall responsibility for the disposal of municipal wastes is with the Department of Health, Education, and Welfare, the Bureau of Mines is interested in the recovery of the large metal and mineral component of these wastes for recycle to industry. Under the present methods for disposing of municipal wastes, which amounts to about 165.000.000 tons per year, nearly twelve million tons of valuable metal are buried every year in dumps and landfills. The total value of ferrous and nonferrous metals in the 165 million tons of waste, based on current prices is estimated at over $1 billion.

The Bureau's preliminary work on this problem has been on recovery of metals and minerals from municipal incinerator residues. Since most of the refuse from large cities, and approximately one-third of the total municipal refuse, is processed by incineration which concentrates the metal and mineral values, the residue from municipal incinerators represents a good starting material for recovery of these values. When refuse is incinerated, it is reduced about 75 percent by weight. Our analyses show that each ton of residue from municipal incinerators contains about 550 pounds of metals. Of this about 500 pounds is iron and the rest consists mainly of aluminum, copper, lead, tin and zinc.

In addition to the metallic residue, for every ton of refuse incinerated about 20 pounds of fly ash is generated. Our analyses have indicated that this waste may become an important source of secondary silver, since it contains silver in amounts ranging from 2 to 9 oz. per ton, and gold in amounts ranging from 0.02 to 0.05 oz. per ton. About 500,000 tons of the fly ash is now generated annually from municipal incinerators and, if economic methods could be developed for collection of the ash and extraction of the metals, this seemingly unlikely source could yield appreciable quantities of silver and gold to help meet the Nation's industrial and commercial demands.

The current status of the research on munipical wastes is as follows: Mechanical separation methods have been devised to separate the residue into several components. Some of these would be saleable to scrap processors without further treatment, while other need additional processing to enable them to be fully utilized. Work has been started on the development of methods for this processing.

TAILINGS

Tailings are materials rejected during concentration of minerals and there are hundreds of millions of tons of such material throughout the country. Because of the varying composition of tailings piles from different sources, no one process can be found to solve the total problem. We are working on several techniques that can be broadly applied to the majority of tailings piles.

There are tailings that contain minerals which should be extracted and utilized from the standpoint of conservation. A prime example of this type is the red muds generated during the production of alumina from bauxite. These muds (now being generated at the rate of over 5 million tons per year) contain large quantities of iron, aluminum, and titanium. We have already worked out a process for recovering part of the aluminum along with significant quantities of soda (added during the processing step) and returning them to the process. Work is currently directed toward recovery of the remaining aluminum and iron. Other research on tailings involves the possible use of these wastes as a component of bricks, building blocks, or other construction material.

Many tailings piles are composed of relatively barren material. In these, the originally desired mineral has been efficiently extracted and there are no accompanying minerals worth removing. For these tailings, the only solution is disposal in an efficient and unobjectionable manner. We are investigating two methods for doing this. One involves chemical treatment for temporary stabilization, followed by fertilization and seeding with selected seeds to provide a permanent cover of vegetation which will minimize or prevent wind and rain erosion and the accompanying air and water pollution. The scenic blight caused by barren tailings dumps is also minimized by this procedure. The other approach to disposal involves injection of slurried tailings into underground strata. This technique has been shown to be technically feasible even for relatively coarse material, and the economics are now under investigation. In addition studies are in progress to develop costs of solid waste disposal at selected mineral and fossil fuel mining and processing plants and to develop guideline and expertise for disposing of solid wastes that may accumulate in the future. Particular attention is given to mined-land-reclamation practices which start with the opening of the mining and/or processing plant, continue through the period of active operations, and provide for reclamation or restoration of the mined-out area to a useable condition after active operations have ceased.

SCRAP

Although the scrap processors are generally quite efficient at returning scrap metals to industry for reuse, there are some types of scrap that are not used to their full potential. Low-grade iron scrap, contaminated by nonferrous attachments, appears to be one of the major problem areas in the scrap picture. The largest source of this type of scrap is the obsolete automobile, although large appliances such as refrigerators, stoves, and washing machines also fall in this category.

We have developed a process by means of which nonmagnetic taconite (an iron-bearing mineral now being put in waste piles around taconite plants) can be converted to useable magnetic iron ore by roasting with low-grade iron and steel scrap. In the process the scrap, while converting the taconite to useable form, is itself converted to high-grade iron ore. We have successfully operated the process on a small scale using automobile scrap, old refrigerators, tin cans, and other forms of scrap.

Another segment of our scrap research is concerned with the development of hydrometallurgical or chemical leaching methods for producing clean scrap from automobiles or from byproducts of auto-scrap processing yards.

FUTURE PLANS

Now with this description of our research in municipal wastes, tailings, and scrap in mind, let me take just a few moments to tell you something of our future plans. In our work on municipal wastes we intend to study the feasibility of recovering metals from raw (as collected) refuse. Funds permitting, a demonstration plant, designed to operate on a continuous basis, will be established, preferably at the site of a modern municipal incinerator. This plant will allow a complete economic analysis of the recovery system to be made and will serve as a model for municipalities which wish to establish similar plants.

Tailings stabilization work on test plots will be continued. Major copper and uranium producers in the Southwest are cooperating closely with the Bureau in this work and, if small-scale tests are promising, large areas will be treated by the companies with Bureau experts acting as consultants. Work on converting tailings into a raw material for construction and for making clay and ceramic products will be continued until the work reaches a stage where it can be taken over by commercial producers of these products. Research on underground disposal of wastes will be continued until fairly reliable economic data are available. If the process appears to be feasible, cooperation will be sought from a company with tailings-disposal problems in conducting a large-scale test.

Research will also be continued on the upgrading of nonmagnetic taconite by roasting with scrap. In cooperation with the Institute of Scrap Iron and Steel and the American Foundrymen's Society, an extensive program of research will be started to evaluate the feasibility of preparing low-grade scrap for efficient foundry or steel plant use by various melting processes.

We will continue the research-grant and contract program to supplement our inhouse research. The grant and contract program is closely coordinated with the solid waste research activities of the Department of Health, Education, and Welfare. The program includes financial support and technical guidance in the training of engineers and scientists in the field of solid waste disposal. Results of the program will add significantly to the store of knowledge needed for an effective attack on solid waste problems and the information gained will be applied wherever practicable for the benefit and welfare of the general public.

Solid wastes from mining, milling, and smelting of minerals are increasing rapidly as consumption of metals and minerals increases and the ore producers are forced to mine and process greater quantities of lower-grade materials. In the public interest, we need to exploit the knowledge and skills of personnel at universities and research organizations to supplement that of our own personnel in their attack on the problems involving utilization or disposal of these wastes. Of approximately 18 grants in force in 1968 about a dozen will be continued in 1969. The program includes work on the potential use of tailings of various types for the fabrication of ceramics, building materials, and insulating materials and the recovery of mineral values where possible. Removal of anthracite refuse banks in the heavily mined region of northeastern Pennsylvania, and recovery of useful materials from such banks are included in the grant program. The six contracts in force in fiscal year 1968 will be completed but no new ones will be started.

In more than 150 years of mining in the Anthracite Region of Pennsylvania over 900 million tons of mine refuse have accumulated. Today there are some 22 refuse piles containing more than 60 million tons of material that are on fire. These "burning banks" pose a menace to public health and safety and in general seriously affect the economy and welfare of a large and heavily populated region.

A demonstration project is underway at the Baker Bank in Scranton, Pennsylvania for the purposes of evaluating methods for extinguishing and disposing of burning refuse banks. Information gained from this demonstration could be used for planning action programs for the orderly quenching and removal of refuse banks that significantly contribute to the degradation of the environment.

This concludes my statement, Mr. Chairman. I shall be pleased to answer any questions that may have occurred to you or the committee members.

Mr. DADDARIO. This committee will adjourn to the call of the Chair.

(Whereupon, at 12:10 p.m., the subcommittee adjourned to the call of the Chair.)

ENVIRONMENTAL QUALITY

TUESDAY, MARCH 12, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:30 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order.

We are late this morning because the full committee was called to vote on another matter. That always takes priority over subcommittee meetings.

I would like to say that we have already entered the era of ecological management at the time when man must base his decisions on knowledge of an entire ecosystem and its future status, not just local short-term effects.

I make this rather sweeping assertion because the testimony in these hearings on environmental quality makes it clear that any alternative procedure for society contains great and immediate hazards.

We are all aware of the excited voices which urgently present examples of unanticipated consequences of applied technology—and we need to listen to them. We are all aware that our standard of living depends on an expanding industrial economy, accelerated by scientific research and development—and we want to maintain these conditions for ourselves and extend them to all peoples of the world.

These viewpoints are not contradictory in my opinion—for man is the dominant species. It is not wrong to manipulate nature for the benefit of human beings. Applied science and technology have momentum and direction of themselves but they can be controlled by man.

My optimism stems from the conviction that our instincts and precepts in the progress of civilization have been right and are right today. The complexity of decisionmaking has increased enormously—but so has the collective knowledge and the means of applying it. Courage is indicated, not despair.

Ecology is a major discipline in the IBP organization and I am pleased to have an opportunity in these hearings to bring out more detailed information on this science and profession.

Today we will hear from some outstanding ecologists who have not been content to remain at their "Waldens" but have taken up the task of bringing their profession into the arena of public affairs.

Our witnesses are Dr. LaMont C. Cole, Cornell University, president of the Ecological Society of America; accompanied by Dr. John E. Cantlon, Michigan State University, president-elect of the Ecological Society, and Dr. Frederick Sargent II, University of Wisconsin-Green Bay, chairman of the Committee on Human Ecology; and Dr. Edward S. Deevey, National Science Foundation, section head, Environmental and Systematic Biology.

(Biographical sketches of Drs. Cole, Cantlon, and Sargent are as follows:)

DR. LA MONT C. COLE

Born: Chicago, Illinois, July 15, 1916.

Degrees:

S.B. University of Chicago (Physics), 1938.
M.S. University of Utah (Biology), 1940.
Ph. D. University of Chicago (Zoology), 1944.

Positions:

Fellowships and Teaching Assistantships, 1940–44.
Officer, U.S. Public Health Service, 1944–46.
Instructor and Assistant Professor, Indiana University, 1946–48.
Assistant Professor and Associate Professor, Cornell University, 1948–53.
Professor of Zoology, Cornell University, 1953–65.
Chairman, Department of Zoology, Cornell University, 1964–65.
Professor of Ecology, Cornell University, 1965–.
Chairman, Section of Ecology and Systematics, Cornell University, 1965–67.

Editorial experience:

Associate Editor, Ecological Monographs, 1951–53.
Associate Editor, Ecology, 1946–48.
Review Editor, Ecology, 1952–54.
Zoological Editor, Ecology, 1958–63.
Member, Publications Committee, American Institute of Biological Sciences, 1963–.
Chairman, Publications Committee, Ecological Society of America, 1966–67.
Author of about 75 papers in various scientific journals.

Offices in societies:

Biometric Society, Member, Regional Advisory Board for Eastern North America, 1952–54.
Ecological Society of America, Vice-President 1964, President-Elect 1966, President 1967.
American Institute of Biological Sciences, Member, Governing Board 1964–, Member, Executive Committee 1965–, Vice-President and President-Elect 1967.

Miscellaneous:

Member, Natural History Survey Committee, Indiana Academy of Sciences.
Special Advisor on Population Problems, University of Pittsburgh, School of Public Health.
Several times member special advisory panels for Office of Naval Research, American Institute of Biological Sciences, U.S. Public Health Service, National Institutes of Health.
Member, Advisory Committee on Environmental Biology, National Science Foundation, 1958–61.
Visiting lecturer, NSF summer institutes for teachers, University of Utah, Montana State College, Oregon State University, Bucknell University, Colby College, University of California, Santa Barbara.
Member and Acting Chairman, Committee on Public Affairs, Ecological Society of America.
Member, Ecology Study Committee, Ecological Society of America; Chairman, Subcommittee on Environmental Pollution.
Commissioner, Commission on Undergraduate Education in the Biological Sciences (CUEBS).
Chairman, Special Review Team for Mathematics-Statistics, National Institutes of Health.
Member, Panel on Systems Ecology, National Academy of Sciences-National Research Council.
Member, Bioinstrumentation Advisory Council (BIAC), American Institute of Biological Sciences.

DR. JOHN EDWARD CANTLON

Date of Birth: 6 October 1921

Education:

Bachelor of Science, University of Nevada, 1947
Ph. D. Rutgers University, New Brunswick, N.J., 1950

Experience:

1940
Field Assistant, U.S. Department of Interior, Grazing Service, Summer
1942–1945
Aviator, U.S. Navy
1947
Teaching Assistant, University of Minnesota Biological Station, Summer
1947–1950
Teaching Assistant, Botany, Rutgers University
1950–1952
Assistant Professor, Botany, George Washington University
1953–1954
Senior Ecologist, Arctic Studies, Physical Research Laboratory, Boston University, Boston, Massachusetts, for field investigations in Alaska
1954–1958
Associate Professor, Michigan State University, Ecology
1958–present
Professor, Michigan State University, Ecology
1959, 1960, 1962
Visiting professor, University of Michigan Biol. Sta., Pellston, Mich.
1965–1966
Program Director, Environmental Biology, Division Biology & Medicine, National Science Foundation, Washington, D.C.

Honorary Societies:

The Society of the Sigma Xi, Chapt Pres. 1966–67, Phi Epsilon Phi, National Botanical Honorary Society
Phi Kappa Phi

Membership in Learned Societies:

Ecological Society of America, Secretary 1958–61; Vice Pres. 1965–66; President 1968–69
American Association Adv. Science-Fellow
Botanical Society of America
American Institute of Biological Scientists—Member Gov. Board 1962–65
American Society of Naturalists
Michigan Academy of Arts, Science and Letters

Consultantships, Panels, etc.:

Advisory Panel, Env. Biology Program, BMS, NSF 1961–1965, Advisory Comm.
Health Physics Program, Oak Ridge
National Laboratory 1966; Division Environmental Sciences Advisory Comm., NSF 1966–.

DR. FREDERICK SARGENT II

S.B., M.I.T., 1942; M.D., Boston U., 1947
1948–1967—Univ. of Illinois
Clinical instructor in medicine (1948–1950)
Professorial lecturer in medicine (1962–1967)
Assistant, Associate and Professor of Physiology
Director, Center for Human Ecology (1965–1967)
Director, CIC Biometeorology Graduate Program (1963–1968—Univ. of Wisconsin, Green Bay
Professor of Human Ecology
Dean, College of Environmental Sciences
Acting Dean, College of Human Biology

Member, USNC for IBP; Chairman, Subcommittee on Human Adaptability, NAS
Member, Biometerology Panel, USNC(IBP) and Committee on Atmospheric Science, NAS
Member, Committee on Environmental Physiology, Div. of Med. Sci., NAS
Chairman, Committee on Human Ecology, Ecological Society of America
Member, Air Pollution Training Committee, NCAPC/USPHS (1963–1967)
Member, Committee on Bioclimatology, American Meteorological Society

STATEMENT OF DR. LA MONT C. COLE (CORNELL UNIVERSITY), PRESIDENT OF THE ECOLOGICAL SOCIETY OF AMERICA; ACCOMPANIED BY DR. JOHN E. CANTLON (MICHIGAN STATE UNIVERSITY), PRESIDENT-ELECT OF THE ECOLOGICAL SOCIETY; AND DR. FREDERICK SARGENT II (UNIVERSITY OF WISCONSIN, GREEN BAY), CHAIRMAN OF THE COMMITTEE ON HUMAN ECOLOGY

Dr. Cole. Thank you, Mr. Chairman. I am happy to be here. I have prepared a short statement, or rather short statement and then I would like to touch on a couple of other points.*

Ecology is the most interdisciplinary of the sciences. Properly, it should provide the scientific basis for, among others, such diverse fields as agriculture, wildlife management, fisheries, forestry, some areas of public health, exploitation and utilization of mineral resources, city planning, and the impact of man on the environment.

In actuality, agriculture, mining, and industry have grown to their present state virtually without consideration of ecological principles. The impact on the environment is becoming intolerable. Soils, bodies of water, and the atmosphere are polluted with a great variety of materials. Areas of originally usable land have been destroyed as have potentially valuable bodies of water.

The lack of consideration of ecological principles has created problems with pest species, and attempts at correction have been singularly little influenced by ecological knowledge. At the same time other actually or potentially valuable species of plants and animals have been exterminated.

Many ecological relationships are very subtle. Had ecologists been consulted they might have anticipated the disastrous effect of the Welland Canal on Great Lakes fisheries. Ecologists did predict the demise of Lake Erie. Ecological studies now could be used to forecast the consequences of cutting or defoliating tropical rain forests whether in Africa, Asia, or Latin America.

Tropical ecosystems (plant and animal communities together with their nonliving environments) are often very fragile and can be permanently destroyed by unwise attempts to manage them. Again the ecological factors are very subtle and involve the nature of the community itself, the types of soils, the microorganisms in the soil, the climate, and the ways in which the climate will change as a result of altering the plant community. These complexly interacting factors are all too often not considered when man sets out to alter a region, and ecology is not a traditional factor in the planning.

Today we are polluting the environment more rapidly and with more materials than ever before, and the rate is increasing. We are generating more inert wastes such as plastics and glass than ever before, and vastly more highly reactive wastes such as radioisotopes. Before the controlled release of atomic energy it is estimated that all of the radioisotopes under human control consisted of about 10 grams of radium. Today a nuclear plant is being built near Oswego, N.Y., which, it is estimated, when in operation, will every day release into the atmosphere radioactivity equivalent to 130 grams of radium.

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*See also app. B, p. 551, for additional information furnished by Dr. Cole.

We are hearing recommendations for major modifications of the earth which have drastic ecological implications. Some of these are utterly irresponsible and others are well-intentioned proposals from able persons who are simply unaware of the ecological implications. I have several times heard leading chemists, thinking about ways of aiding agriculture, propose ways of intervening in the nitrogen cycle which, if successful, could spell the end of life on earth.

We are talking about modifying the weather (which, incidentally, man has inadvertently been doing since his early history), of connecting the Atlantic and Pacific Oceans by a tropical sea-level canal; of mining the ocean bottoms and at the same time trying to farm the surface waters, and of innumerable other schemes with vast ecological implications which are simply not recognized by their proponents.

All this is very frightening to one who does see some of the implications, and I know ecologists who have simply given up and hope that they will not be around to see the final disaster for man. However, in the Ecological Society of America, we have not given up. We have formed a vigorous Committee on Public Affairs which represents a place that policymakers can come to for competent ecological advice.

The Ecology Study Committee, which represents the long-range planning arm of the society, has studied alternatives and has concluded that we must establish some sort of a "National Institute of Ecology" which can bring together in readily retrievable form the existing information about ecosystems, which can insure that research is conducted on vital questions where we are at present largely ignorant, and (perhaps of greatest interest to this subcommittee) which can put a mass of authoritative knowledge and thinking at the disposal of policymakers who need advice on ecological questions. We want this institute to have the capacity to undertake studies in depth when it is presented with a problem for the solution of which the necessary data do not yet exist.

The trouble in the past, at least in this country, has been that policymakers have either failed to recognize ecological implications or have directed their questions to bodies of scientists and engineers that were not qualified to give advice on ecological problems. Environmental management policy has been based on considerations of economics, engineering convenience, and political expediency, but seldom on esthetic consideration and even less often on sound ecological considerations.

Mr. Daddario. Dr. Cole, when you say that in this country we haven't done these things, where have they handled the situation better or are you just pointing to our own problem.

Dr. Cole. I just didn't want to be too broad on this. I think England has done a bit better than we have, but it has been far from what it should be anywhere.

Chairman Miller. Doctor, isn't England putting rather high-level atomic waste into the North Sea?

Dr. COLE. I don't know the amounts going into the North Sea. Of course they are creating high-level atomic wastes and they have had at least one rather serious reactor accident.

Chairman MILLER. As you know, there is a counter current under the Gulf Stream.

Dr. COLE. Yes.

Chairman MILLER. Can the effect of this high-level waste, if enough of it gets into the North Sea, do some damage on the Grand Banks and to the fisheries off the New England coast? I believe these isotopes have an affinity for shellfish, particularly.

Dr. COLE. It would depend on what they are putting in there. If they are putting strontium-90 or cobalt-60 in there these could accumulate in shellfish and could cause tremendous damage. Cobalt-60 wasn't even known to be produced by the bomb that contaminated the island of Rongelap in the Pacific and yet 2 years after the blast, the shellfish there were extremely radioactive. They wouldn't be safe to have on your table.

Mr. DADDARIO. My reason for asking the question was just to get the definitions right. You are just referring to what we are doing and you are not in any way intending by this to make comparisons to other areas?

Dr. COLE. No.

This proposed National Institute of Ecology, in addition to its functions as a research organization, data center, and advisory body will seek to further the infusion of ecological information into education at all levels. In testimony I gave 2 years ago before the Senate Committee on Interior and Insular Affairs I emphasized that we do not now have enough qualified ecologists and that not enough are being trained to conduct the studies and furnish the advice that society urgently needs.

The Ecology Study Committee of the Ecological Society of America has just undertaken, by means of a questionnaire, to learn what the training situation actually is. A summary of the results will be presented to you by Dr. Edward S. Deevey, Jr., of the National Science Foundation who is a regularly attending observer of the ecology study committee.

It is clear to me that the Nation simply must step up the training of ecologists. There is simply no substitute for the type of interdisciplinary approach which is instilled in ecologists. Attempts to solve our environmental problems solely by the narrower traditional approaches employed by physical scientists and engineers will, in my opinion, invite disaster.

Now there are two other things that I wanted to include in the testimony but in the haste in which itw as prepared I didn't get time to put these in. Incidentally there are copies of the present statement about the National Institute of Ecology available to you. One is the question of giving ecologists field training. This is an outdoor science, and our people just simply have to get out and see how ecosystems really work and it is a pet project of mine that I hope we can bring to fruition, that we will perhaps under this Institute operate a number of field stations and laboratories, one with access to interesting bodies of fresh water, one marine station, one in the Tropics, one in the Arctic or Alpine situation, and one in an arid land situation, and if we are going to have thoroughly trained ecologists that can answer the questions and provide advice on the things we are doing, they need experience in all of these areas.

The second point I wanted to make has slipped my mind at the moment. It will come back to me.

Mr. Daddario. Yes.

Are the next two statements going to touch on the National Institute of Ecology and spell it out a little bit?

Dr. Deevey. Mine will not.

Dr. Sargent. Mine will not.

Mr. Daddario. If we could touch on that a moment, how do you structure it, where do you place it, or who is going to be involved?

Dr. Cole. I am preparing letters to approximately 20 ecologists representing schools that have established programs in ecology. These will go out probably next week, along with this summary statement on the Institute which you have available here, and will ask for an expression of interest and willingness to form a corporation of individuals as the parent body for this National Institute.

Our plan is that this Institute will be run by a consortium of universities, and our thinking at the moment is that this corporation of individuals will be converted over into a corporation of universities, a consortium, when a certain number, perhaps three universities, have actually agreed to come in and support the program.

I have received a tremendous number of letters expressing interest from schools that don't want to be left out of this, places that I would never have thought of as having an ecological program, so there is a very great deal of interest in this and a strong feeling of need.

Mr. Daddario. Dr. Deevey, how does this fit into the planning of the National Center for Atmospheric Research?

I am concerned about this because we have a tendency to develop new institutional concepts rather than take into consideration those that presently exist and meld them together so that you do have a mixture of thinking. A mixture, it seems to me, is extremely necessary in this regard. Have you given this any thought?

Dr. Deevey. At the moment the group that has been making the plans assumes, not perhaps having thought it through, that the National Center for Atmospheric Research is a model and not a stage for a National Institute of Ecology. The procedures that ecologists would adopt in developing such an Institute are closely similar to those the atmospheric scientists adopted 15 years ago or so. But atmospheric science now has its own momentum and a very great deal of its high quality has been generated in the theater of this relatively spectacular, strong, and influential group of central premises there at Boulder.

The idea that ecology might be conducted in the way the ecologists believe it must be from that institute; that is, from NCAR, has not really been given much thought. Ecology needs and gets close collaboration with atmospheric scientists, but what that would amount to is you would have to transform a substantial fraction of them or add to them a substantial fraction of biologically trained rather than physically trained scientists. It might come about that the two institutes, if the Ecology Institute had central premises, might sit side by side at Boulder. In any case, the field stations that the Ecology

Institute would be concerned with would not in all cases be the same field stations that the atmospheric people need. However, there are some that well might be the same.

Mr. DADDARIO. I don't ask the question because I contemplate you have this all fitted into your mind, nor do I believe that you do, Dr. Cole, but you are thinking about the establishment of an Institute, which you would have to in some way work harmoniously into presently existing activities.

Mr. COLE. Yes; we appointed a subcommittee of the Ecology Study Committee to prepare the original proposal for the National Institute and they met out in Boulder and looked over the NCAR organization very carefully, so there was a good deal of input from there into our plans.

If I may, the other point I wanted to touch on has come back to me, and this is related to the Institute. There is a very great need to acquire natural areas, natural ecosystems that can be preserved for research purposes. The analogy has been made that medicine didn't get very far until they began intense study of the healthy human body anatomically and physiologically and the same thing applies to ecosystems. None of us know enough now to look at even such a small ecosystem as one drainage basin for a river and predict just what some particular modification may do to the life there. These things have to be studied in their entirety and they need to be set aside for research before man destroys them, and the same would apply to marine communities and estuaries and bodies of fresh water and so on.

(The following additional information has been supplied for the record:)

A NATIONAL INSTITUTE OF ECOLOGY: SYNOPSIS OF THE PLANS OF THE ECOLOGICAL SOCIETY OF AMERICA

Ecology is the scientific study of life-in-environment. It is not, for instance, the science of management, which is a form of political engineering. It is not the study of resource allocation, which is a form of economic engineering with sociopolitical components. Nevertheless, sociopolitical and economic decisions regarding resource management and allocations are, in significant degree, ecological decisions; professional ecologist have the necessary knowledge, as well as the duty, to participate in such decisions. They expect to do so, not by "calling for a stronger voice for ecology in public affairs", or by combating some hypothetical opposition, but simply by doing better ecology.

STATUS OF THE PLAN

The Ecological Society of America has sought for at least twenty years to find better mechanisms for doing better ecology. It now proposes a *national institute of ecology,* with research-and-development centers on the pattern established by the National Center of Atmospheric Research, as such a mechanism. The proposal has been received in draft form by the Study Committee of the Society (LaMont C. Cole, chairman). It was drafted, with the assistance of a grant (G-6073) from the National Science Foundation, by a small planning group (Charles Cooper, Shelby Gerking, R. S. Miller, chairman) appointed by the Study Committee. At the meeting (Washington, D.C., December 8, 1967) that considered the report, the Study Committee voted to implement the proposal by asking several distinguished ecologists (names and number suggested but left unspecified) to take legal and fiscal advice and incorporate themselves as a national institute. It was understood that operating ownership of the institute would quickly pass to a group of universities, and it was suggested that the founding members should hand over control when five universities had agreed to join the institute. The "committee of founding fathers" has not yet (February 16, 1968) been formed.

The Program Director for Environmental Biology, NSF, attended the December 8 meeting. At the suggestion of the chairman, he has prepared this synopsis of a longer document for the information of the NSF staff and others who have reason or wish to discuss the Ecological Society's concept. Word of the developing plan has reached the press (e.g. *Science*, January 19, 1968, page 287), and has been brought (without written documentation) before the Executive Committee, NAS/NRC Division of Biology and Agriculture, and before Committee I (Research) of the National Science Board. It must be emphasized that in no sense is this interim report a proposal before the National Science Foundation.

OUTLINE OF THE PLAN

1. *Need.*—A national institute of ecology is needed, (1) to conduct those kinds of ecological research that cannot be conducted by independent investigators working in single universities and laboratories, but require substantial field facilities and concerted multidisciplinry team effort; (2) to help coordinate the nation's ecological research by providing centralized information-storage-and-retrieval facilities on which ecologists and public agencies can draw; (3) to coordinate and strengthen those activities of ecologists that (in Rep. Daddario's words) "involve ecology in relation to public affairs as well as the education of ecologists and the infusion of ecology into general education at all levels"; (4) to perform advisory services for agencies of government and industry that express in some meaningful and constructive way "an ecological view" of action programs affecting environment. Of these needs, (1) and (2) are immediate and obvious, and can be fulfilled *only* by a national institute and a professional staff; (3) and (4) are thought of as no less urgent, and *may* be fulfilled by a national institute, if only because of its strong research programs and high visibility; but a single national *research* institute is not the only mechanism, or necesarily the best mechanism for fulfilling them. These matters need continued discussion, in which the Society's Public Affairs Committee will undoubtedly take a leading role.

2. *Need for research on ecosystems.*—Ecosystems, being partly conceptual, are elastic units; for some purposes, mainly literary, "spaceship Earth" or all of North America are ecosystems. Working ecologists rarely concern themselves with such large units. Very small ecosystems, such as old fields, small lakes, or those that can be synthesized in the laboratory, need much more reserach, but most of it can continue to be independent and the facilities required are conventional. However informative, the results of such studies cannot be extrapolated to larger patches of nature, containing more biological and environmental diversity, without loss of rigor or predictability. Ecosystems that require substantial field facilities and new modes of concerted team research are those of intermediate scale, of the order of drainage basins, "airsheds", and biomes such as grassland and tundra. Such systems are geographically dispersed, and their geographical variability is intrinsic to their scientific interest. As they cannot be brought into any laboratory, laboratories must be brought to them.

New technologies, mainly geophysical, geochemical, and statistical, have only recently enabled ecologists to study terrestrial systems of such magnitude. (In aquatic ecology, especially oceanography, the ecosystem concepts and the technologies have been available for a longer time.) The necessary intelectual resources obtained by interdisciplinary collaboration, are rapidly being developed. Any kind of team research needs careful attention to its organization if high quality and scientific initiative are to be preserved. It is this kind of organization, as much as the day-to-day conduct of the research, that a national institute of ecology is intended to provide.

In all systems defined and studied on this comparatively large scale, man's activities are environmental parameters that range from important to dominant. Man-dominated systems, like other systems, do not produce energy, but only transform it. If attention is concentrated on the output of ecosystems, the ecological term is "productivity." When the focus is on internal transformations and frictions, one appropriate word is "pollution." "A pollutant is a resource out of place." It follows that understanding of the metabolism of ecosystems—both positive and negative aspects—is the chief practical benefit, as well as the chief intellectual satisfaction, of ecology.

Examples of projects on large-scale ecosystems, all genuinely multidisciplinary, are the Yale-Dartmouth-U.S. Forest Service project at Hubbard Brook, New Hampshire, the OTS tropical-forest project in Costa Rica, and the IBP-sponsored program on Analysis of Ecosystems, which plans intensive and comprehensive study of six major biomes.

These examples are from terrestrial ecology. Older, more familiar examples are all aquatic, such as the AEC-sponsored study of the Sargasso Sea, or the International Indian Ocean Program. A much older example (ca. 1916) is the work of the San Francisco Bay Marine Piling Commission, a pioneer estuarine project that badly needs re-doing. It is as examples of "pure" science applied to large systems that ecologists find these projects intellectually exciting. It is noteworthy that all are using or plan to use human influences ("disturbance") as a technique of experimental or quasi-experimental manipulation. The notion is that only under controlled stress can the homeostatic properties of complex systems be fully tested. As this familiar strategy is applied to large and complex systems containing men and their culture, any distinction between "basic" and "applied" research tends to become meaningless.

3. *Research and "development" functions.*—The primary function of the national institute, with its scientific staff working out of one or more well-equipped laboratory centers, should be to conduct research in general ecology. It would do this by bringing all the resources of modern science to bear on understanding large ecosystems in their totality. Projects would be partly self-generated, and partly undertaken at the request of government agencies and industry. Funding of the latter, at least, would be contractual; the independence of the institute to accept or reject projects must be assured. "Development" in this context is not management or exploitation; it is understood to be the *methodological* development (remote sensing, computer technology, etc.) needed to do better fundamental research. Human influence on ecosystems can never be ignored, but the focus of the institute's research should be on life-in-environment, not on human ecology *per se.*

4. *Educational and public-information functions.*—As a coordinating research arm of several universities, the institute would play a major role in ecological education. Its explicitly educational functions are regarded as secondary, however, in the sense that most of them would proceed automatically from a program of high-grade comprehensive research. Initially they would be exercised through such tested devices as pre- and post-doctoral traineeships, foreign-exchange fellowships, affiliate professorships, lectures, seminars, and short courses, and informal "institutes of advanced study". More innovative and perhaps more effective devices for improving ecological education at all levels would have to be developed with care, if propaganda and political advocacy are to be avoided. Particular care would have to be exercised if *any* educational or advisory functions are undertaken with the support of public funds.

5. *An economic model.*—Ecologists see no essential differences between ecology and economics, in respect either to academic orientation or social significance. In fact ecology can be considered the natural-science component of economics, and at a very abstract level its governing concepts are mathematically equivalent. Ecologists therefore note with respect and some envy the degree to which economic ideas are internalized by all educated persons. Moreover, politically concerned but conservative ecologists admire the ability of economists' professional organizations to devote themselves to free though socially-oriented inquiry while remaining politically uncommitted. Such an organization as the Brookings Institution is therefore an attractive model for a national institute of ecology. Its organization and research programs were studied by the subcommittee, and emulation is strongly recommended. The Brookings' private endowment is not so easy to emulate, however.

6. *An atmospheric-sciences model.*—A closer analogy, in that both are natural sciences, utterly dependent on data from a global field, and use partly identical methods, exists between ecology and atmospheric science. The subcommittee therefore looked at the National Center for Atmospheric Research (NCAR) with special care. In some respects the NCAR model may be unnecessarily elaborate. Ecology has less need than meteorology for synoptic data, gathered simultaneously on a continent-wide or world-wide scale, and some of the instrumental and human apparatus that is essential for good meteorology would be wasteful duplication in ecology. The idea of a central facility that is both a palladium and a cynosure, though strongly appealing, was not considered essential by the subcommittee. In all important respects, however, good ecology and good atmospheric research have identical needs—for a nuclear scientific staff and flexible research program, for coordinated field stations and mobile laboratories, and for central premises and program services—and NCAR was found to be a near-perfect model of a national institute of ecology. Outstanding among its attractive features are

NCAR's strong and responsive relations with university-based science and education, and the subcommittee paid special attention to the sponsoring and governing roles of UCAR, the parent consortium of universities.

7. *Institutional arrangements and alternatives.*—A national institute of ecology is so clearly in the national interest, and would so obviously be dependent on contractual relations with the federal government for much of its funding, that the plan for an independent, private research agency may seem to usurp the prerogatives of government. Federal laboratories for the study of life in environment already exist. Many members of the Ecological Society work in them. Could not one of these be enlarged, or several of them be linked together, to accomplish the objectives of a national institute? The idea has much appeal, especially to foreigners familiar with such research arms of national governments as the Natural Environment Research Council (UK), the C.S.I.R.O., the D.S.I.R., and many others.

Only a little familiarity with U.S. federal research is needed, however, for the idea to lose much of its charm. Which federal laboratory or agency might assume the functions that ecologists have in mind? To which department should it be attached? Ecologists note with mingled amusement and despair that polluted water "belongs" to Interior, polluted air "belongs" to HEW, polluted soil "belongs" to USDA, while AEC, potentially the most dangerous polluter of all three environments, is the chief federal sponsor of research on ecosystems. All these agencies have responsibility for action programs, for surveillance, and for enforcement of policies. In this context, fundamental research rarely carries highest priority when funds are reduced.

No disrespect is intended by these remarks. Federal scientific research is excellent science. There are many good reasons for the situation that exists, and there is a great variety of coordinating devices. But it seemed to the subcommittee, after some reflection (and much first-hand familiarity with several kinds of federal support for ecology) that no government agency is (or no new government agency can long remain) nimble enough, far-sighted enough, or in close enough touch with the universities where the nation's real scientific strength lies, to substitute for an independent national institute of ecology.

In calling, not for "better liaison", but for action that is within the capacity of university-based ecologists, the subcommittee was aware that the recommended institutional arrangement, a consortium of universities, is also beginning to lose some of its charm. At least academic administrators are doubtful that their own institutions can participate in many more of them, without detriment to their own fundamental objectives. As public-administration devices, consortia are undergoing rapid evolution; some are already quasi-independent "management corporations", and some may follow the COMSAT route to a "public-private corporation". The subcommittee recognized its own ignorance of administrative matters, and preferred to leave the corporate form of the national institute of ecology to development in more experienced hands. It suggested only that (as with UCAR) a fiscal officer of each founding university be included among the "founding fathers". In any case, the subcommittee was familiar with the Organization for Tropical Studies (OTS), recognized its near-identity of purpose with a national institute of ecology, and assumed that the members of OTS would be the most appropriate member universities, at least initially. The fact that the Central University of Costa Rica is a member seemed to point in the right direction; the participation of Canadian, West Indian, and Mexican Universities would add enormously to the strength of the proposed organization.

8. *Open questions.*—At this stage in the Study Committee's planning, a large number of questions, including the name and some aspects of the nature of the proposed national institute of ecology, are left open. The Committee can and does recommend, but all further decisions remain to be taken. These include the form and provisions of the articles of incorporation, the list of "founding fathers", the mode of financing, the choice of a Director, the size and nature of his staff, the scope and direction of the research program, the number and location of operating centers, and the degree to which the institute goes beyond its research functions to perform roles in ecological education and public affairs. Advice will be needed from many people, and not just from ecologists. Presumably, by the time suitable candidates for staff positions are identified, and a Director chosen, most policy decisions and many research plans will have been made. The Committee hopes for expeditious progress but does not urge haste.

9. *The role of the Society, and of the National Academy.*—The Ecological Society of America is a learned society, founded on a 17th century model, and its

main (and vitally important) function is to promote interchange of scientific ideas between scientists. Those who expect it to restructure its own organization "to meet the needs of science in the 20th century" simply do not know scientists, or understand how science is done. Some of the best-endowed learned societies in the U.S. have strong organizations and central offices but do not *conduct* scientific researach, though they sponsor a great deal of it, and publish much more. Neither can the Ecological Society accept corporate responsibility for research that it sponsors, evaluates, or publishes. Still less can it be placed in any nonscholarly stance involving political advocacy, "educating the decision makers", or many of the action programs some of its critics would like to undertake.

It follows that in recommending and in effect sponsoring a national institute of ecology, the Society neither changes its own role nor becomes legally or even scientifically responsible for the institute's organization or program; it expects to remain free to criticize, to publish, or not to publish ecological research done by or under the auspices of the national institute. Thus, if its Study Committee's recommendations are followed, the Society's position will be that of godfather, not parent, and it can only hope that the relation will be one of which it can be proud.

Similar considerations apply to the National Academy of Sciences. Through its study groups, the committees and boards of the National Research Council, the Academy would be bound to take notice of the existence of a national institute of ecology. It would often be obliged to appraise its programs, recommend or perhaps contract for new ones, or (a function which seems imperative to ecologists) refer many environmental problems to the national institute for study and advice. The Academy's National Research Council, however, is not an "operating arm", as research councils are in other countries. It evaluates, stimulates, and sponsors research projects, but it owns no institutes and conducts no research in its own name. There is no reason to expect it to own a national institute of ecology.

In 1962 the Academy issued a report (NAS/NRC Pub. 1000A) that said, in part, "It seems vital to establish without delay a broad-gauged agency charged with the continuing examination, identification, and assessment of changes in the natural resources picture, and of their potential effects upon each other . . . Such . . . an intelligence agency (would) be able to feel the pulse of the ecosystem, as it were, and to register and assess incipient developments before they have reached critical dimensions . . . The contemplated agency should not, however, be given powers of decision or enforcement, and it should steer clear of the political arena." Noting that this sounds remarkably like a national institute of ecology, the Study Committee assumes that the NAS/NRC will look with favor on its own efforts to bring such an agency into being.

Mr. MOSHER. Mr. Chairman.

Mr. DADDARIO. Mr. Mosher.

Mr. MOSHER. One of the practical examples mentioned in the testimony is the disastrous effects of the Welland Canal on Great Lakes fisheries. I don't want a long dissertation on that, but I would like two or three further sentences. What are you talking about there?

Dr. COLE. I might qualify that to the extent to say that the original Welland Canal opened in 1833, I believe, and if this started the disastrous effects, ecologists couldn't have predicted it. The present canal was opened in 1932 and then they could have been predicted.

What happened was little forage fish, the alewives, moved through the canal into the upper Great Lakes and the sea lampreys moved in. They are predatory on trout and similar fishes. The sea lampreys increased in numbers until they wiped out the white fish industry in Lake Michigan and Lake Huron and they damaged it in Lake Superior.

Now the trout were apparently keeping down the alewives by preying on them. With the demise of the trout as a result of the sea lampreys, the alewives could multiply without limit, essentially. Consequently last year we had the situation of Chicago and Milwaukee beaches just littered with piles of dead alewives.

Mr. Mosher. You mean the canal gave access to the Lakes?

Dr. Cole. Yes; you see they couldn't cross the Niagara Falls and the Canal goes around it.

Mr. Mosher. You think that someone might have anticipated that, if consulted?

Dr. Cole. By 1932 I think they might have, yes.

Chairman Miller. Doctor, I think there are lots of examples where people use live bait when they fish and when they are through fishing, if they haven't used all of the bait, they dump them into the stream and the first thing you know these fish are taking over the stream.

Dr. Cole. Those are usually carp and they have damaged a great many lakes in that way.

Chairman Miller. The Sacramento River and San Joaquin River, are filled with carp. I would be interested in knowing how they got there. There was a man of German extraction that had some land on a low-lying island in the Sacramento River. He sent to Germany and had the lake stocked with carp. Then he invited his friends up because these are great fish in Germany. Then a break came and the carp washed from the lake into the river.

Dr. Cole. There are many such examples. Both the starling and English sparrow were brought into this country deliberately and rabbits were introduced deliberately in Australia. In fact, they didn't take the first time. It took a second introduction to get them established.

Chairman Miller. Mongoose were brought into Hawaii.

Dr. Cole. And in Jamaica too. They would love to know how to get rid of the mongoose now.

Mr. Daddario. You touched on the need to set aside certain areas untouched and uncluttered by man at this time. Considering the problems we have here and recognizing that in most instances it is impossible, how do you intend for your National Institute, from an ecological point of view, to get the kind of a reading on the problems that presently exist in the various river basins? Each of these is different. Would you be able to make recommendations so that we can readjust and turn them back into unusable streams?

Dr. Cole. I think we will have a very important start on that from the international biological program. There are proposals to study in detail the desert biome, the grassland biome, and a number of studies on different types of river basins. These will be interdisciplinary studies going into the chemistry and hydrology as well as the biological situation and putting all of this together we will be able to form much better judgments about the functioning of these systems we can at present.

Mr. Daddario. Your answer to that then is that the Congress should take into consideration programs presently before it, such as the international biological program, and see to it that those programs are funded so that you can develop this capability which doesn't presently exist and will not exist unless that program is properly funded?

Dr. Cole. I think that is very important. Now it could be done through a national institute, but since detailed proposals have already been prepared to get started on this, why that seems to me like the logical way to proceed.

Mr. Daddario. Dr. Cole, you have been quoted to the effect that the oxygen in the atmosphere might be depleted by certain manmade changes. I wonder if you could touch upon the evidence that is there. How can this be understood so that man could with good judgment do what is necessary to overcome the problem?

Dr. COLE. Well, the only reason there is oxygen in the atmosphere is that green plants are continuously putting it there by photosynthesis. These are plants not only on land but also in the oceans where about 70 percent of the oxygen is generated. Photosynthesis stops at night in the dark and on land and high latitudes it practically stops during the winter, so we are dependent for oxygen being produced in other places being brought in.

Now, every year we are burning fossil fuels faster than we did the year before, and all of this is using up oxygen, so we are increasing the rate of use and at the same time we are cutting off plants on land and the Food and Drug Administration estimates that we are putting half a million different types of chemicals into the oceans without any study being made of whether these might be poisonous to the marine plants or not.

If we should by some miscalculation poison all of the marine diatoms, this would cut off 70 percent of our oxygen supply and the oxygen content of the atmosphere would start to decrease unless we agreed to a moratorium on burning fossil fuels.

I have attempted some very rough calculations for this country. The data aren't very good, but I took the 1966 rate of use of fossil fuels in the United States, the coal, petroleum and natural gas, and assumed that it was all completely oxidized, and I compared this with what could be produced in the way of oxygen by the plants in the 48 coterminous States, and to the extent you can trust these rough figures, we are using oxygen 1.6 times as fast as our plants can produce it, so we are absolutely dependent on its being brought in from the Pacific Ocean and Mexico and similar places.

As I say, I am not very happy with these data, but I think we are in the right ballpark with that estimate. We can't go on paving a million acres of land each year and putting it out of productivity without risking eventually some at least local crisis with the oxygen in the atmosphere during winter nights, say, but these widescale atmospheric movements are not even well enough known to let us put down really precise figures on this risk.

Dr. SARGENT. Mr. Daddario, I would like to add another dimension to Dr. Cole's statement. I draw from my article "Adaptive Strategy for Air Pollution," a reprint of which you have. Weather modification from the burning of fossil fuels and the discharge of other wastes into the atmosphere is now well recognized by meteorologists. Information published last year in Science by Ludwig and McCormick from the Taft Sanitary Center in Cincinnati indicated that the turbidity of an atmosphere has increased about 77 percent at Davos, Switzerland, where there is a meteorological station of 100 years' duration, located at 1,604 meters above sea level, far away from big cities. An increased turbidity of the atmosphere means that radiant energy coming to us from the sun is being reduced and the photosynthetic process which Dr. Cole talked about depends on the receipt of this solar energy.

With still greater increases in the turbidity of the atmosphere, a point may be reached at which the input of solar energy becomes inadequate to drive the photosynthetic process.

Another influence that man has had that is reducing the input of solar energy is the jet airplane. These aircraft produce a vapor trail. Dr. Roberts of the National Center for Atmospheric Research has produced some beautiful pictures showing these contrails evolving into cirrus clouds. The cirrus clouds reflect sunshine back into space and it does not get to the plant.

There is also an increase in the number of freezing nuclei. Vincent Schaeffer of the State University of New York at Albany has shown an increase in freezing nuclei. These nuclei contribute to the growing haziness of the atmosphere. These influences, which are over and above what Dr. Cole has mentioned, threaten the oxygen supply of the atmosphere because they reduce the energy that drives the photosynthetic process.

Mr. **Daddario**. On your jetstreams, are you theorizing?

Dr. **Sargent**. I do not refer to the jetstreams, but to the contrails made by jet aircraft. The picture on the front of my article which you have shows—illustrates this phenomenon. Dr. Roberts gave me that photograph.

Mr. **Daddario**. By jetstreams, I really meant jet aircraft disturbances. Are you theorizing there or do you believe it is a hard reality that this is what is taking place?

Dr. **Sargent**. Yes, I believe it is taking place. More and more frequently one sees the vapor trail or the contrail evolving into a cirrus deck.

Mr. **Daddario**. Why don't we continue on? Either Dr. Cantlon or Dr. Sargent can continue with their remarks.

Dr. **Sargent**. I think we had Dr. Cantlon scheduled next.

Dr. **Cantlon**. Let me first make one observation about the oxygen matter since it is before you.

It is worth reflecting that a fairly sizable percent of the oxygen released from the sea is released in a relatively small number of the major upwelling areas in the ocean surface. The recent disaster on the English coast of an oil tanker, and the more recent one in Puerto Rico, is enough to give us pause. What happens if one of these increasingly more massive tankers flounders in a place that contaminates these big upwelling areas, and what happens if the petrochemicals it is carrying happen to be reasonably herbicidal in nature?

We are dealing now with phenomena, the scale of which requires somewhat more care. These matters shouldn't alarm us, but we should be thinking forward to what might be the result of, and what are the probabilities of occurrence of a series of these kinds of things. I don't think it is necessary to be overly worried about this at the moment, but these are things we ought to begin getting better data on.

Chairman **Miller**. Where do these upwellings in the ocean take place? Aren't they pretty much located all over the ocean?

Dr. **Cantlon**. No; they are highly localized. For instance, the big Peruvian upwell. As a matter of fact they occur in the very places in which the great world fisheries occur, and the reason the fisheries are there is the presence of the upwell.

Chairman **Miller**. I can tell you a story about that. I used to be executive officer of California fishery and game. We used to catch sardines off the coast of California and they made extensive studies trying to find out why this took place, but it wasn't until after I was in Congress that they were briefing me on what might be the effects of dumping atomic wastes into the Pacific, and a young biologist mentioned this. I said, "Why do you catch them there?"

He said, "There is a big sea mount down there, Mr. Miller, and the ocean current comes in and it wells up." Of course, this brought the fish, the food life of the fish and such to the surface. I thought these upwellings were well scattered pretty much throughout the world.

Dr. CANTLON. That is right, and if you look at the matter of percentage of oxygen release, we need not contaminate the total ocean. Enough herbicide unintentionally released in a relatively selected group of local areas might add a serious additional burden on our oxygen circulation system.

Mr. DADDARIO. I have another question in my mind, but I think Dr. Deevey has something.

Dr. DEEVEY. If I may simply interject a related biogeochemical point to what Dr. Cantlon has said. The matter of the sulfide system is of extreme importance, likewise, to the maintenance of oxygen in the oceans and in the atmosphere. We have now begun to realize that the sulfate-reducing bacteria, most of which probably exist in the sea bottom or on the continental shelves in blue muds, and also in the bottom of lakes and marshes—in anaerobic situations, make their living by reducing sulfate to sulfide. That leaves the oxygen behind, you see, in the course of reducing the sulfur. Thus, although one understands this not at all on a global scale, it is essential to get a clear picture of the relative metabolism of sulfur as compared to the metabolism of carbon, which is what this amounts to.

It looks as though the sulfide-sulfate system is the major balance wheel that keeps the system operating. What follows then is that a threat to the metabolism of all of the sulfur bacteria in the sea would be as great a threat to the maintenance of oxygen in the atmosphere as the destruction of all the green plants.

Mr. DADDARIO. Dr. Cantlon, in answer to the chairman's question, you sort of capped it off by saying it is nothing that we really ought to be so concerned about at the moment. One of the points that sticks in my mind in Dr. Cole's statement is that these things ought to be planned. We are putting much of our land under concrete and macadam and what not, and in Vietnam we are certainly not planning what is going to happen by the defoliation processes. Shouldn't we be concerned and shouldn't we put this thing into perspective so it can be understood?

One of the problems in this whole area is that statements are made, some of them scary and some of them not so scary, so finally people just kind of shrug their shoulders about them. The more I hear about it the more I am convinced that there is a present need for planning so the people will understand why it is important.

Chairman MILLER. Mr. Chairman, the areas being defoliated in Vietnam would be miniscule compared to the rain forests in Vietnam and in Southeast Asia, let alone the rain forests in South America. I don't think we want to get too scared of what is going on there. It is a comparatively small strip. I think what we must be concerned with is the effect of chemical pesticides and certain chemical fertilizers that get into the river basins and are washed to sea and into our estuaries.

I think they are consuming as much oxygen as some of these other things. Isn't this a real threat that we are concerned with right now?

Mr. DADDARIO. Mr. Chairman, I am subject to the same problem in my thinking process as you people. When these points are raised, such as defoliation, and it may not be the most important, but certainly you have to take all of these things into consideration.

They all play a part; don't they?

Dr. COLE. Yes.

Chairman MILLER. Long before the word "defoliation" was introduced, 'way back in the eighties, a copper plant was established in California that completely defoliated 10 times more, or 100 times more area as will be defoliated in the war in Vietnam. It left red hills that eroded. I know you know where the area is I am talking about. Now fortunately it is under water. It is part of that area that forms Lake Shasta. However, as a result of a copper operation, you went through lands that looked like the deserts of Australia.

Dr. COLE. I agree with Mr. Daddario and I am worried about these things. I think the important point is that man is now so completely predominant in the world and he is doing all of these things at once and just trusting to luck that he won't bring on a disaster.

For example, DDT is now practically a normal constituent of the world environment. It has turned up in the fat of penguins in the Antarctic and can be found in the ice on Alaska glaciers and places where it has never been used, but if that happened to be a deadly poison for some of the essential microorganisms, we could have put the world out of business by now.

Chairman MILLER. Isn't it deadly to microorganisms?

Dr. COLE. Very recent studies have shown DDT is definitely damaging the algae growth in Long Island Sound.

Mr. DADDARIO. You did say that ecological studies now could be used to forecast the consequences of defoliating tropical forests, and ecology is not a traditional factor in planning. I don't understand that to mean it is a dangerous situation, but because it has been done it gives you a laboratory within which you can come to some determination about what this does mean and you can put into better perspective what ought to be done in other areas.

Dr. COLE. Some tropical rain forests probably can stand the use of defoliants and others can't. The important thing is that most of these tropical soils are very low in nutrients and the nutrients that come down with leaf fall and falling trees and so forth have to be recycled. The plants have to be in growing condition there to seize these or they leach out in the ground water.

Now this can be studied ecologically. You can study the streams draining an area before and after defoliation and actually measure the losses of these essential nutrients, such as fixed nitrogen and phosphates and things of that sort. A very recent study published in Science refers to an area up in New Hampshire where they have done just this. They have measured the mineral content over several years of the streams draining this watershed and then they cut the trees off up there and sprayed a herbicide to keep the vegetation from regenerating and found a tremendous increase in the outflow of nutrients that plants require.

In tropical regions this is likely to be much more serious because the soils are so poor in nutrients in the first place, but you would have to study this situation in Vietnam to tell whether you are doing something that will prevent that rain forest from regenerating.

Mr. **Daddario.** The opportunity to study it ought to be taken advantage of.

Dr. **Cole.** I would think so; yes.

Chairman **Miller.** I think that it is highly essential that you study it.

Mr. **Daddario.** Would you proceed?

Dr. **Cantlon.** I would like to start off with paraphrasing the remarks of a scientific colleague at an advisory committee for one of the Federal agencies in which we were discussing ways of attacking our burgeoning environmental problems. His remarks brought this discussion to a climax and this is approximately what he said:

I keep hearing strong pleas for encouraging the investigation of natural purification phenomena and the need for more and better ways to halt increasing pollution. Why aren't we concentrating our scientific efforts instead of increasing tolerance to pollution?

That is a rather interesting thought, and at a quick assessment, it looks like this is indeed an oversight. Yet with a little quiet reflection, you can see that such a view is itself symptomatic of the aimlessness with which we have addressed ourselves to our environment because it is based on two rather false premises.

First, it assumes that the present forms of pollution that we now suffer are themselves essential and inescapable byproducts of our modern industrial living; and, second, that man and a very few domesticated plants and animals are the only creatures on earth that we need to worry about.

Now setting aside one's own moral and ethical considerations about which organisms deserve to live on this planet, we can address ourselves to man's strategy for maintaining a satisfactory environment in a more coldly scientific way.

It has been said many times that resources out of place really are pollution. Pollution wouldn't exist if we effectively managed our resource system. Sewage-contaminated water is not only degraded water, it also represents potentially useful organic materials. Heat pollution from our powerplants might actually be utilized in a more effective waste processing system. An engineer faced with designing a system for processing wastes would like to have a cheap source of energy, while in another part of the same surburban area unutilized heat may be creating its own separate pollution problems.

An approach which looks at the overall pollution mix may well yield not only useful insights into improving environmental quality, it could lead to intrinsically valuable technological breakthroughs. I think it would be a disaster indeed to assume we are stuck with our present kinds and amounts of pollutants. We surely shouldn't expend scarce public funds to increase tolerances to today's stupidities. I think this would be the worst possible thing to do.

However, generating even more trauma in ecologically aware persons is this widely held nonsense that man and a veritable handful of domestic plants and animals are all that are essential to maintain the ecosystems that sustain us. If this were true, we could learn to love pollution, we could breed our domestic plants and animals to resist pollution and evade forever the responsibility and the expense of halting our accelerating rate of pollution. A moment's reflection on Dr. Cole's earlier remarks clearly demonstrates that we don't have this option.

We cannot permit the demise of large numbers of the earth's essential, but poorly known organisms. This is just not a possible course of action. A rather spine-chilling observation in this regard is that no man and no group of men right now can tell us which of the creatures that are on this earth are necessary to continue in good health the systems that sustain us and those that inspire us. There is no way at this moment to figure out what the irreducible biota for our biosphere is.

Mr. DADDARIO. Does that lead us to the conclusion that they all are important?

Dr. CANTLON. In the absence of positive information it is safer and more comfortable to assume they can all play a role.

It is rather interesting to note that it now costs something to keep 30-odd whooping cranes from becoming extinct. At what point do we shift each additional species to a special jeopardized species list and assume the burden of preventing its extinction?

Chairman MILLER. You ought to take that off the record because you will have some conservationists in here who value the whooping crane.

Dr. CANTLON. I would be on their side. Don't misunderstand me. I am not opposed to conserving species. I think this is a highly pertinent operation, but it is an expense we need not have to bear. We should not permit species to be driven to so precarious a position.

Mr. DADDARIO. Any concern about the ones being killed off without our knowing anything about it?

Dr. CANTLON. Very much so. The very large bulk of the organisms in the soil are as yet unknown. We not only don't know which forms are there, we don't know what impact herbicides, insecticides and chemical fertilizers are having on them. Nor do we know what the impact of smoke, smog, and changes in plant cover will be. We don't know what is happening to the biota of the estuaries, the Continental Shelf and the ocean in rigorous detail. We have no clue, really.

Now to think that we could breed resistance to any sizable list of pollutants (Dr. Cole mentioned a list of a half million chemicals going into the sea)—imagine trying to breed resistance in any sizable number of species to a half million, or even 50 pollutants.

Mr. DADDARIO. Don't you develop resistance every time you ride up the Jersey Turnpike?

Dr. CANTLON. I don't know whether it is resistance or resilience.

Mr. DADDARIO. It is certainly not tolerance.

Dr. CANTLON. You are right.

Chairman MILLER. I am glad you used that and not George Brown's Los Angeles area.

Dr. CANTLON. It is obvious that this idea of breeding tolerance is patently absurd as a fundamental pollution strategy. I referred earlier to a case of a competent scientist advising such a course of action to a group of people addressing themselves to pollution and environmental quality problems. How can we explain having a man that well educated and that ignorant? This is really a worrisome thing because the

Congress, the Federal agencies, State and local governments are all seeking advice and they are getting mixed signals.

Mr. **Daddario.** Maybe he was just trying to stir people up, that is all.

Dr. **Cantlon.** He succeeded.

Chairman **Miller.** Doctor, how are you going to do this when scientists themselves or people who are accepted in a discipline make mistakes, or make statements that you would expect a layman to make. I am a layman. During the war when food was scarce there was great pressure on us to increase the amount of fish that could be taken off the Pacific Coast and no less than a dean at the now University of California, at Davis—then the farm school—made a very dogmatic statement that you could produce so much food per acre on lands, you could produce so much food out of each acre of the ocean.

Do you agree with that?

Dr. **Cantlon.** It depends on the piece of ocean.

Chairman **Miller.** That is it, but he didn't say that. It was just so many millions of acres of ocean and what we could take out of it. He knew more about that than perhaps a good fisherman.

Dr. **Cole.** This is why we are trying to tell you to come to the ecologists for advice.

Mr. **Daddario.** That is the point. We would like to know what the prescription is, rather than the warning about these things. How do we put it all in place? Do we have enough ecologists, and education? What is the program? What do you suggest?

Dr. **Cantlon.** Let me move ahead then since you are already aware of the need for improvement.

First of all let us look at public education, it is here I think we have to start. It is worthwhile noting that every State to my knowledge, requires that every student in the public schools be required to take a course that tells him how his Government works. These are courses in civics, American Government, or whatever. Most public school curricula also require, for example, either in physical education, hygiene, or other courses, instruction in how his own body works. These are essential things, but to my knowledge there isn't a single State in these United States that requires a course that instructs the student in how the systems that sustain him work—not one State. This is a rather remarkable thing, a glaring gap in a modern urbanite's education.

Now currently there is in operation around the country some attempts to instill a sort of conservation ecology in the grade schools and there are various kinds of training programs in this regard. While I think these are rather useful, I think that we may in fact be making another rather serious blunder.

If we are going to communicate to the urban dominated population of this country at the moment, we have to give him a systems view of his world and give him some comprehension of how this "complex machine" works that gives him his food and his water and removes his wastes. He doesn't get that. You can't give it to him by taking him out and showing him a beautiful, pristine brook or lake or waterfall or a forest. He has to learn it in terms of the system he knows, which is his home. There is no reason in the world why you couldn't instill a fairly adequate systems knowledge in a youngster in terms of how his home works, considering what it takes to sustain it. How much watershed, how much agricultural land, how much energy, transportation, oxygen, and so forth.

Maw bringing in the groceries is bringing in a quantity of energy. We have the tables for converting various produce to energy units. This could be a fairly adequate mathematics problem for the youngster learning his mathematics. The weight, energy and crude chemistry of his garbage and waste materials again could be calculated. How much water does it take to serve a family and how many square miles of watershed are necessary to guarantee this much water, etc.

We could incorporate such instruction from elementary level through high school and replace a fundamental flaw in our whole educational system. This flaw is the total absence of a systems look at the world in which he lives. This would be one of my first recommendations.

Now I think a second kind of thing that we need to seriously consider is deliberate stimulation of more research into the natural purification phenomena. There is a whole array of natural purification processes operating in our ecosystem; for example, atmospheric particle scrubbing, phosphorous uptake in streams, et cetera. It has been suggested (and I don't have the slightest clue as to whether this a valid, scientific assessment or not) that one might be able to scrub a large part of the smog out of the California airshed by artificially generating small thundershowers. If this can be done by some reasonably economical means, it might be cheaper to use atmospheric scrubbing rather than direct source removal. I don't suggest that this is wise; I use it as an illustration only.

We ought to know a great deal more about the biological uptake of inorganic nutrients by aquatic and terrestrial ecosystems. Here you have 2-billion-odd years of evolution which has been operating to favor organisms with elegant nutrient scrubbing capabilities. These species have lived in a world in which nutrients are scarce. They are microscopic systems that are self-generating and self-maintaining. I would defy any engineer to design a system that is self-generating, self-maintaining, minutely divided, and can run on solar energy. We ought to be exploiting these systems much more effectively than we are in abating pollution. It occurs to many of us that appropriate coupling of the need for green space, and processing of waste water could be explored. Southern California has already begun and many untried avenues beg exploration. Again, the gain comes from a systems view of the whole array of opportunities. What is waste in one context can in another be a valuable resource.

Thirdly, I would say that modeling and simulation of natural and manmade ecological systems ought to be greatly expanded and encouraged. Chairman Daddario mentioned this at the beginning and I am in complete agreement. We don't have enough data at the moment to do this adequately. Nevertheless some rather interesting and even startling first approximations have been made by Dr. Frederick Smith at Ann Arbor. He has been using the crude but best available data for computer simulation studies of stability in ecological systems. What happens when one species is reduced or doubled by an order of magnitude in these complex systems? The outcomes in the computer simulation were unpredicted by the ecologists who have been looking at these systems. We just don't know enough about them.

The International Biological Program may be one means of getting a better understanding of these complex systems. I think we could enhance a very fundamental piece of this Nation's science and technology by supporting the U.S. contribution to the IBP.

We ought also to be thinking in terms of semidomestication of relatively complex microcosms. By microcosms I have in mind small arrays of multiple species such as the little terrarium we have probably all seen as youngsters in school. These microcosms have beautiful experimental properties, but more than that they have absolutely irreplacable bioassay capabilities.

We need to be able to predict what the systems outcome of a particular pollutant might be. Now, if one deals with pure cultures and makes a study of the behavior of one organism, it may not give you a clue about the behavior of a system of species. While no two systems behave the same a consistent effect of a pollutant on a range of bioassay microcosms could be useful in understanding more about pollution.

We ought really to be screening major parts of the world's genetic and ecological information for its potential in pollution abatement. The USDA has for many years operated a plant introduction center and an animal introduction center. They have been looking at a small fraction of the world's biological diversity with the idea of how you might eat it, wear it or enjoy looking at it. No one to my knowledge is seriously searching the world's biota to find a better species—or more likely—better species combination to crack the phosphorus problem before it destroys our lakes. We ought really to be exploring this sort of thing.

Now to return to the matter of advisers—and it's worth noting that you don't have anything like unbiased people sitting in front of you here today. We think ecologists have some useful things to say and we are delighted you have given us a chance to say some of them, but I think that a word of caution is due here.

Ecologists working alone don't provide a really useful advisory unit. The ecologists, the engineers, the economists, the sociologists and the political scientists together make the kind of body ultimately that you are going to need. Those of us who have been active in the Ecological Society have observed the creation of an environmentally oriented board or advisory committee that pronounced and evaluated programs in this area, but on which there wasn't one ecologically knowledgeable member. Prestigious, yes; intelligent, yes; ecologically educated, no.

Now I think that the idea of a Council of Ecological Advisers is one kind of way. I don't pretend to have thought this one through enough to know whether that is the best way to do it. This issue is really your realm anyway, not ours. It does seem to me that an interagency committee working alone is utterly ineffective for this type of need. I don't believe an interagency committee can in fact override the vested, long-entrenched interests of the respective individual Federal agencies. Interagency coordination is an absolutely essential partial ingredient, but by itself it cannot create and it can't really evaluate long-range merits between alternatives. So I would close by saying there are a number of avenues I think that we could move ahead on and I am very pleased to know you gentlemen are seriously considering it.

Thank you.

Mr. DADDARIO. You are very kind, Dr. Cantlon, to come and give us this statement. I hope we will have a chance to come back and ask you some questions.

I think we ought to proceed, however, with Dr. Sargent and Dr. Deevey.

Dr. **Sargent**. I am chairman of the Human Ecology Committee, and in that capacity would say a few words about the area of human ecology. I am also a dean, so I hope you will be kind to me, Mr. Miller.

Chairman **Miller**. Oh, I am very kind. Don't get me wrong, Doctor. I just tell you these things because sometimes even in the sacred white towers you need a little cleaning out. Maybe it is in some of those towers that the ecologists find most of its resistance rather than here.

Mr. **Daddario**. There are hardly any of those white towers left any more.

Dr. **Sargent**. In Green Bay we just have a large field, in which someday there will be a university campus.

The area of human ecology has only recently been established within the ecological society but it has had a long tradition which has been rather stormy. I think the position that the current Committee on Human Ecology prefers to take is that really there is only one ecology; what we need to do is bring man back into the ecological thinking.

I think Dr. Cole's remarks emphasize that point of view. Man is a unique organism among the animals that inhabit the globe primarily because he has chosen a somewhat different way to adjust to his environment than other organisms. He has what we call culture. He can modify his environments. For a long time he modified his environment without much regard to the impact the modifications might be having. Now we are faced with a situation where his capability of capturing energy, molding and extracting from the landscape, and so on is producing effects which are harmful not only to him but to the whole living environment.

Our task in human ecology, within the context of the Ecological Society of America, is to bring the human component back into ecology. We are really dealing with one ecology and man's dependence on one terrestrial ecosystems, if you will.

The committee has posed several questions which are in line with John Cantlon's remarks. These are questions which we would like to deal with in a national conference for which we are currently seeking financial support. These questions would be of interest to you, I think, because they relate to the work of your subcommittee.

The first question is, Can systems analysis be used to solve the problems of urban integration? I don't pretend to know the answer to this question, but it does raise some intriguing possibilities.

The second question is, what insights into the use of resources can be derived from basic strategic processes of social and political behavior? The use of resources is largely determined by these behaviors and about them we need to have much more understanding.

What are the alternative strategies for managing the introduction of manmade substances into the biosphere? Here an example is the use of silver iodide in weather modification. Silver is a toxic substance. Not very much is known about biogeochemistry of silver. The evidence so far from measurements of silver in the environment resulting from cloud seeding is that it is at very low levels, but Dr. Charles Cooper of the University of Michigan and I have become concerned about whether or not silver might concentrate as it flows through the ecosystems in the same way that the DDT concentrates.

Somewhere along the line in an organism in the hierarchy of organisms from the primary producers up to the higher consumers, there will be a buildup of silver and a toxic level will be reached in the tissue.

Since so little is known about silver and its biogeochemistry, it would behoove us to look at this matter. How is silver managed in ecosystems? We are using it very extensively in cloud seeding operations at the present time. Of course this same concept applies to the question of biocides which Dr. Cole has covered quite adequately.

Another question is, What are the economic implications of environmental quality control via recycling of wastes and regulation of technological productivity? I think you dealt with this question in your report on "Environmental Pollution." This is an unanswered question that needs to be given serious consideration.

Still another question is, What are ecological implications of the quest to broaden man's resource base, for example, the quest for water and food? One of the programs aimed at broadening the water resource base is weather modification. In this context a high priority is modeling ecosystems. With mathematical models of ecosystems, one can experiment through the use of computers rather than actually manipulating natural processes. Dr. O. W. Roberts has stressed this viewpoint in a number of recent talks. It would be much less disastrous for man to examine the ecological consequences of weather modification by manipulating the meteorological factors in a mathematical model than to proceed empirically with intervention in natural processes.

In our quest to increase our capability to produce food, we introduced fertilizers and pesticides; these practices have produced problems such as those Dr. Cole has alluded to. We can look on agriculture really as dealing with manmade ecosystems. These ecosystems have to be managed by man and they have to be kept rather primitive so they will have maximum productivity. Because it did seem to be a major factor enhancing productivity, we have greatly augmented the nitrogen used as fertilizer. This material is now running off into our ground waters where it may lead to nitrate intoxication in those drinking the water. Eutrophication of streams and lakes is another end result of such wasteful use of fertilizers.

So these implications have to be looked at very carefully. One matter that has increasingly bothered me about the handling of the environmental quality problems is that we have fragmented our approach. Separate agencies, groups, boards, and committees tend to focus their attention only on water or only on land or only on air or only on the urban environment. Each is really a part of one system and I think in order to make an effective approach to these problems we have to work more closely together. The interactions among these various system components, as we understand from ecology, is very great. Therefore we need to focus our attack on environmental pollution more broadly more ecologically.

In your report of 1966, you urged that a way to attack these problems would be to create an effective consortium of government, industry, university, and community. My feeling here is that the university must play a stronger role than it has in the past. The ecological problems are truly exciting and they are as worthy of serious attention from scholars and students as the problems adopted by the so-called basic sciences.

Some would argue such ecological problems as I have in mind here as we have been discussing this morning, are in the province of applied science, that the responsibility of the university is to train young people in basic disciplines and basic sciences. I say this is a hollow argument for the tradition that has hallowed this position is that research is only basic when it is human activity pursued in the laboratory where conditions can be precisely regulated, variables isolated and causal relations among dependent and independent variables readily proven.

Reality is complex and causation stems from shifting multifactor configurations frequently acting over a long span of time. Because there is now little basic information on which to meet the solutions to these ecological problems, the scholars' attitude towards these problems must change and universities must shoulder the responsibility of leadership, move out of insular laboratories into the human environment and attack the problems for their own sake with as much vigor as they exhibit toward further probing the properties of matter or molecular basis of life.

It seems to me the type of natural area approach, for example, which Dr. Cole mentioned is an example of what I have in mind. The problem of the urban environment Dr. Cantlon mentioned is another aspect of this. We have tended in the universities to slide the responsibility for investigating these problems to institutes, to systems development corporations of one kind or another, and have said that our job is to train the student in basic science. I think the definition that we have here of basic science must be judged in its historical context.

We institutionalized science about 100 years ago and said anything that was done in the university was basic, and that which was done outside of the university in the real world was applied. Since man created this definition of basic science, I think we can change it. The universities have a major responsibility, their faculties must leave the insular laboratories and move into the field, into the real environments, and to train their students to handle the serious problems facing man.

Now is any university doing anything about this? Well, I am happy to say that this is exactly the program that we are attempting to develop at the University of Wisconsin, at Green Bay. This institution was established on March 10, 1967, when the board of regents approved the preliminary plan for its educational program. Just last week the Committee on Programs and Policies of the Coordinating Council on Higher Education of the State of Wisconsin approved our academic plan. I have a copy of this plan if you would like to see it. We hope that Thursday of this week the full council will approve the program visualized in this document.

(Note: the plan was approved on March 14.)

The objective of this new institution is to deal with these types of problems, to train our students in a problem-oriented way so that they will be more ecologically qualified and more ecologically sensitive to the very urgent matters that we have been discussing this morning. Now insofar as education is concerned, I feel that the decisions we make in the next three or four decades are the most important decisions that we as humans will make. It is a question of priorities here whether we should focus our attention on educating children or educating adults.The adults are the people who are really going to have to deal with the problems that we now face. These environmental problems are sufficiently urgent so that they have to be grappled with effectively by the present adults. By such actions the children that we are bringing along will have an environment that is fit to live in.

I do not think, however, that we should neglect by any means the education of the children. I think John Cantlon's ideas are very exciting ones. I have been working with the Green Bay school system during the past few months. The staff has developed a title III grant application to establish what they call a wilderness laboratory in the vicinity of Green Bay to educate children from kindergarten through grade 12 in ecology and conservation. One of the difficult educational problems I have had is to broaden the perspective of the teachers who are manning this program.

They take the position, just as John said most do, that if you take the kids out and show them a nice woods, they will understand about ecology. I said: "Look, you have Green Bay and that is a good example of misuse of an environment resource. Let's understand something about how Green Bay got into its present condition." The proposal they have put forward I think is closer to what John has in mind than the original proposal that they submitted.

Dr. A. D. Hasler, of University of Wisconsin, has proposed that we develop ecological clinics in order to educate the public. These clinics could be sponsored by churches, service clubs, and resort owners. By this device we could make the public more ecologically perceptive. The community could then participate more intelligently and more willingly in the social decisions that must be taken to achieve the necessary environmental quality control.

I agree with you, sir, that the public is going to play a very important role in the policy decisions which you have to make and implement. Therefore it behooves us as educators to see that not only do we educate our children, but that we educate the public so that they can understand the type of legislation that is going to be required to solve these environmental quality problems.

Mr. Daddario. Thank you, Dr. Sargent.

Dr. Deevey, we are going to keep going and will try to give you as much time as we can.

Dr. Deevey. Thank you, Mr. Chairman.

(Biographical sketch of Dr. Edward S. Deevey is as follows:)

Dr. Edward S. Dewey

Professor of Biology; Born Albany, N.Y., 3 December 1914; B.A., Yale, 1934; Ph. D. (Zoology), Yale, 1938. Instructor in biology, Rice Institute, 1939–43. Research Associate, Woods Hole Oceanographic Institution, 1943–46. Assistant Professor, Associate Professor, Yale, 1946–; Professor, 1957–. Director, Geochronometric Laboratory, 1951–62. Guggenheim Fellow and Fulbright research scholar, Denmark, 1953–54; NSF Senior Postdoctoral Fellow, New Zealand, 1964–65. Zoological editor, Ecology, 1950–57. Co-editor, Radiocarbon, 1958–.

Publications: about 80 papers, in pollen stratigraphy, limnology, paleolimnology, biogeography, biogeochemistry, and general ecology.

STATEMENT OF DR. EDWARD S. DEEVEY, SECTION HEAD, ENVIRONMENTAL SCIENCES AND BIOLOGY, NATIONAL SCIENCE FOUNDATION

Dr. DEEVEY. The statement I prepared covers a number of things and will take too long to read it; so, with your permission, I will touch a few of the high spots.

It describes in some detail the situation of research support for ecology as we in the National Science Foundation are in a position to see it.

I will preface this by pointing out that, although I am temporarily on official duty, I have been an ecologist for over 35 years and expect soon to return to academic life. To establish what kind of an ecologist I am, I have practiced limnology and paleolimnology, the study of lakes and the history of environment as recorded in lake mud, and I believe the term that best describes my long-term interest is historical ecology.

I indicated, I must confess, chiefly for Congressman Fulton's benefit, were he to be here, that I knew about eutrophication in 1938 and may have been possibly the first to introduce the word from the German language into English. I am mentioning these things because ecology is very hard to define and a forest ecologist or population biologist or environmental physiologist would probably give you a slightly different perspective. Those descriptions were not intended to apply specifically to Dr. Cantlon and Dr. Cole and Dr. Sargent, but in point of fact they come reasonably close. So I am a limnologist and will give you a slightly different perspective, but I think only slightly different, because ecology is concerned with complex living systems and all of these things are complex living systems.

I will first define ecology as the study of life in environment.

So much that is specifically human—sociology, social psychology, urban ecology, et cetera—is included in that definition, and so much that is also called environmental science could be included, that one rapidly draws more narrowly the limits of competence that ecologists draw for themselves. They are biologists and members of teaching departments of biology.

In that context they say they deal with the mutual relations between animals, plants, and their environment. They are concerned with physical properties of environment because they affect physiologies, but they usually place the emphasis on other animals and plants as the most relevant components of an organism's environment; but they also say at once that that subject as so defined is not the whole of ecology, it is environmental biology. Man has an ecology too, but ecologists do not always place man in the center of the picture. They don't claim to be expert in everything under the sun.

Skipping them a little bit about whether there is or is not a department of ecology on an American campus, I learned from Dr. Cole, this morning, that there is indeed one department of environmental biology. I was going to describe in some detail the research support program in the National Science Foundation especially within my program which is called environmental biology. We think we are in close touch with most of the leading practitioners and graduate teachers in the field because we support much of their research, but the details of this support—how many millions for this and that—I will rapidly pass over, unless you want to ask questions.

Mr. **Daddario.** Without going into the amounts spent, would it be helpful to, considering the growing importance of the subject, bring it together under a division of ecology? Do you believe that we are doing the right thing the way we are now by giving support in all of the related areas?

Dr. **Deevey.** I think some greater degree of centralization would be helpful, but I would not for a moment, sitting in the chair where I now do, advocate the consolidation of research support for all basic ecology into one central division, because too many genuinely important scientific problems would be created by doing that.

The present way is pretty good. It is not perfect. Some of us think that a section of environmental biology is, in fact, in operation now, although for various reasons including civil service constraints we don't quite call it that. The alternative you suggest, of taking this whole piece of environmental biology and incorporating it, for example, within the division of environmental science, which includes meteorology and oceanography, atmospheric science and Antarctic programs, et cetera, though it might help ecology, would remove its contact or potentially could remove its fundamental contact with other kinds of biology. The subject is so multidisciplinary that one has to think very carefully before launching an institutional reorganization of that sort because what you gain in one direction you may lose in another.

Mr. **Daddario.** It is because of this multidisciplinary characteristic that perhaps it ought to be in this institute that Dr. Cole is talking about.

Dr. **Deevey.** The National Institute of Ecology, as I conceive it, is quite a different affair from a National Science Foundation and basic research support. A national institute of ecology is large, but not so unmanageable that it fragments again the moment you try to pull it together. It focuses on environmental biology. It recognizes that you can not define the whole of the field that way, but it focuses on this and is intended as a step in several directions at once.

To enlarge the activity or the responsibility of environmental biology, by trying overnight to create some gigantic affair that includes the sociologists, the social psychologists and all the earth scientists too, this would seem—well, it may come in 25 years' time—it is hard to predict—but at the moment the cumbersomeness of such an organization would defeat its purpose, I would say.

One wants to start with what seems to be manageable, what seems to be "doable" and, what desperately needs doing.

Mr. **Daddario.** Well, it is something that needs to be analyzed. We are certainly not going to make a determination about it here and now.

Dr. **Cantlon.** I serve on the Advisory Committee of the Division of Environmental Sciences in the National Science Foundation, and if I might, I would request a clarification here, please?

Are you suggesting the NSF's Division of Environmental Sciences serve as the main ecological unit, or were you asking Dr. Deevey to react to a hypothetical model of a division of environmental sciences in which environmental biology is one of the components?

Mr. Daddario. I am not suggesting anything. I am trying to find out where it all fits in in order to come to some judgment about your recommendations. It seems to me that it does run counter to advice we have been given in the past about the creation of new institutions. When we made recommendations last year that the National Science Foundation ought to have the ability to do some work in the applied area, there was a hullabaloo about that as though these things should never get mixed together.

It seems that this is one of the problems. We always try to separate things, and because they seem to be unmanageable, not manage them.

Nothing is unmanageable providing we know what we want to do, how we want to do it and what resources we are willing to use to accomplish the task.

Dr. Sargent. I am dean of the College of Environmental Sciences. Ecology in our academic plan is one of the environmental sciences. We have just gotten started. How it will work I do not yet know.

Mr. Daddario. I was just going to ask you, how is it doing?

Dr. Sargent. I don't know yet. You can see in the document I have for you how our plan has developed. There is a tremendous national interest in what we are trying to do at Green Bay. Ecologists are very interested. The people I have interviewed for appointments at UWBG are not unhappy at this innovative context for ecology. Because of close intercollege relations, the ecologists will not be isolated from the biologists.

Mr. Daddario. We are extremely anxious to have an opportunity to look at the entire curriculum and discuss it. We weren't trying to get Dr. Deevey to spell this all out and put it in precise terms.

Dr. Deevey. If I might say so, sir, the kind of gigantic or, rather, total responsibility that I think you are trying to construct, and we all want very much to help you on, is a responsibility of the Federal Government at the topmost level. It is a superagency responsible for ecological and environmentally important programs and there are, I think, no action programs that are not environmentally important. But the instrumentalities by which we conduct research or support research in parts of this area need not, and I suspect probably should not ever be amalgamated to the extent that everybody, both the social scientist and the biologist and all are one. The working scientists don't do this. The Federal Government and the President's Office clearly must be able to process all of those kinds of information and many more in order to conduct this work.

We think scientists know pretty well what their limitations are. And ecologists have as many as other kinds. They have a certain view of the total system and it makes their advice exceptionally useful, but they are not to be charged with the responsibility for placing in operation all of the programs that follow from their advice.

Mr. Daddario. Not at all, Dr. Deevey. One of you four said this morning that it is our responsibility, as well as the Executive, to develop policy, but the fact still remains that we have to know in what kind of an atmosphere you can best accomplish your work. We do know that you can't put it in one compact ball. On the other hand, we know too that if you allow it to be proliferated you are not going to accomplish what you ought to do.

There is a need to get things done earlier rather than later. We certainly can't allow the scientists to go along as they have in the past and say, what difference does it make when it comes about.

This can come about 25 or 30 years from now.

In this area the answer needs to be developed sooner. We cannot wait before we at least begin putting things in motion to prevent the negative aspects from becoming more pronounced than they presently are. This is one of the reasons why organization is necessary. The problem is ours. But we need some guidance from you as to what tools you best need to do this particular job.

Dr. CANTLON. One comment in this vein:

It is conceivable that the model developed in the IGY and IQSY and is beginning to emerge in the IBP may actually be a more prudent model for certain of these kinds of operations. One would assume that if a concerted attack on a pollution question were successful, then that particular group ought not to live after it solved its problem. Indeed it should be restructured to solve the next priority problem.

Mr. DADDARIO. Should not be or should not be structured after it solves the problem.

Dr. CANTLON. The group should break up and a new one be restructured with different scientists around a different problem. You see my point is that it is conceivable that our existing model of government agencies may not be the best model for the kind of crash program that I think really is warranted in areas of environmental stress problems.

It is conceivable that what you need is a coordinating group that gets separate line item funding to address itself to one sort of phrasing of the problem. It could have a definite lifespan, the unit breaking up and dying automatically without ossifying and burdening the taxpayers in perpetuity. A new array might then be developed such that scarce talent continually reforms in a kaleidoscopic way around the particular problem to be solved. The universities, the national laboratories, and the pertinent Federal agency laboratories could be the talent reservoir. In a sense we have done this in wartime.

Maybe the sort of flicker we are seeing in these international cooperative scientific ventures is a suggestion of another way of doing it nationally without creating a new monstrous Federal agency to do it. Rather for any particular problem one or more of the Federal agencies might have some significant talent, which could be augmented from the body of talent that exists in the educational institutions and national laboratories. You should not remove too many scientists from their educational institutions or you dry up the source of the next generation of scientists in these areas. What we may want is a short lifetime problem-solving array that disappears when its problem reaches the level where it can be partitioned out to the pertinent action agencies for administering the selected courses of action.

Mr. DADDARIO. Dr. Deevey, you have been in this for a while. Do you go along with that?

Dr. DEEVEY. I think I do.

Mr. DADDARIO. Isn't that what we presently are doing? You don't see all of the development where programs are created and then almost before they get started they are just completely washed out. Mission-oriented laboratories, as an example, are presumed to end at the time when they finish their mission objective, and some of them, in fact, do, but how about talents that we are developing?

I believe we develop a talent in our laboratories which is scarce in this country. This is the ability to take knowledge and apply it. These people learn certain things as they go along. They learn things not related to their mission objective which sometimes allows us to accomplish other programs and which sometimes is not even used as it ought to be because this is not their particular mission.

In many areas, this particular talent of taking different sets of facts, if they were given flexibility, might be a helpful asset.

Dr. **Cantlon.** I agree thoroughly with that. I couldn't endorse it more strongly.

Dr. **Deevey.** I was going to say there was one point I would disagree with Dr. Cantlon on, and that is the notion that the groups must automatically dissolve when the problems are solved.

Environmental problems won't go away, because slightly different, but related problems, will always exist, and the idea of the national institute is surely a permanent one.

Dr. **Cole.** Is the Rand Corp. the sort of model you are referring to?

Mr. **Daddario.** I am not thinking so much of the Rand Corp. I am thinking about how we can better utilize our great applied capabilities which have been developed in our national laboratories.

Dr. **Cantlon.** I would strongly endorse that. I was thinking of a place like Oak Ridge National Laboratory, which is now, in fact, developing a fair competence in pollution problems, and have, I believe, a major proposal before AEC.

No, my remarks were not intended to suggest we dispense with existing national laboratories. Rather, I feel that we shouldn't create a "pollution NASA," that is, one monstrous overriding new Federal agency for monitoring, for researching, for developing, and for enforcing in the area of environment.

Mr. **Daddario.** I look askance at the idea of developing new institutions. I do think that we have too much of a tendency to do this. Somewhere there might exist something which we can utilize better. One of the reasons we are holding these hearings is to get your view of how you are going to accomplish these programs. We are looking to the management of things.

Even though it isn't your job, you are working in them, especially you, Dr. Deevey. Therefore, we would like to ask you about it, because we can then come to a judgment as to whether or not we are in fact managing things as well as we ought.

Dr. **Deevey.** The National Center for Atmospheric Research has been described by one of my colleagues as NSF's outstanding creation, and I tend to subscribe to that. Several other programs have been sponsored by NSF, and one, at least, where there was major operating rather than research supporting activity was not, let us say, the most successful of the NSF's operations by a long shot.

Mr. **Daddario.** And you need not name it.

Dr. **Deevey.** The National Center is a good thing and it will be useful and instructive to study the relation between NSF and the National Center when it was first thought up, and to look at it now as it now exists. It is not NSF's operating arm in atmospheric science, not at all. It is the universities', the science community's operating arm in atmospheric research. Nevertheless, there will be $12 million next year of NSF funds devoted to its program; that is, to supporting its research and providing much of its personnel.

Mr. DADDARIO. Do you include industrial participation in research activities because problems of pollution have their origin in industry? You don't mean to limit this Research Center to just the academic community, I would hope?

Dr. DEEVEY. No.

Mr. DADDARIO. I would hope that you in fact have strong participation by the industrial community because they are not only tremendously concerned, but consumer goods can be produced which can then motivate a great deal of other activity.

Then this is again a management question. How do you feel about it?

Dr. DEEVEY. The instrumentalities for managing large research schemes of this sort are still being developed, just as the idea of the consortium as a managerial device is undergoing rapid evolution. We, at this table, I am sure, do not pretend to be expert in managerial science. That is the kind of "ecology of ecologists" that goes well beyond our competence, but we are willing to help. We simply have some germ of an idea that an adequate managerial science can be developed pari passu with the breathtakingly large-scale, high-quality research on environment, because it must.

Dr. DARRARIO. Gentleman, we have to go to answer a quorum call.

I certainly appreciate your coming here and your cooperation. We have learned a great deal this morning.

(The prepared statement of Dr. Edward S. Deevey follows:)

(PREPARED STATEMENT OF DR. EDWARD S. DEEVEY, HEAD, ENVIRONMENTAL AND SYSTEMATIC BIOLOGY SECTION, DIVISION OF BIOLOGICAL AND MEDICAL SCIENCES, NATIONAL SCIENCE FOUNDATION:)

Mr. Chairman and Members of the Subcommittee. I am Edward Deevey, Head of Environmental and Systematic Biology Section, National Science Foundation and am on leave of absence as Professor of Biology, Yale University. I am deeply honored by the invitation to speak to this subcommittee on the status of ecology as a science and as a profession. Although I am temporarily on official duty, I have been an ecologist for over thirty-five years and expect soon to return to academic life.

To establish what kind of ecologist I am, I have practiced limnology and paleolimnology—the study of lakes and the history of environment as recorded in lake mud—and I believe the term *historical ecology* best describes my long-term interests. Although I have not checked the history of the word, I suspect that I was the first to use the word *eutrophication* in English. I did not invent it. My science was mainly written in German when I was a student, in my doctoral thesis I simply translated *Eutrophierung*, something that seemed very academic at the time. I mention these points of reference, because ecology is rather hard to define, and a forest ecologist or a population biologist or an environmental physiologist would probably give you a slightly different perspective on his kind of ecology. But only slightly different, for ecology is concerned with complex living systems, and forests, populations, and lakes can all be thought of as living systems. Having mentioned *eutrophication*, however, I trust I shall not have occasion again this morning to use a word longer than four syllables.

Let me first try to define ecology. It is the study of life in environment. So much that is specifically human—sociology, social psychology, urban ecology, etc.—is included within this definition, and so much that is also called "environmental science" might also be included, that I hasten to draw more narrowly the limits of competence usually drawn by those who call themselves ecologists. As biologists and members of teaching departments of biology, ecologists say that they deal with "the mutual relations between animals, plants, and their environment." That is, in studying environment, they are concerned with physical properties because they affect physiologies, but they usually place the emphasis on other animals and plants as the most *relevant* components of an organism's environment. But they also say that the subject as so defined is "environmental biology", and is not the whole of ecology. Man has an ecology too, but ecologists do not always place man in the center of the picture, and do not claim to be experts in everything under the sun.

I regret having to use so many words to define my subject, but any non-scientist who has heard of ecology and knows its importance is bound to ask, "Who are the ecologists? How may departments of ecology are there? How many students are being trained in ecology?" etc. And if I reply that so far as I know there is not a single "Department of Ecology" on any American campus, this non-scientist will suppose that professors are made, as usual. In fact a great deal of ecology is taught in most colleges and universities, but under so many names that it is almost impossible to describe the field for the university administrator or the Congress. A device that is being used on more and more campuses is an interdepartmental Institute of Environmental Studies, or some such coordinating program, and we know of at least 45 universities in which such institutes or faculty committees exist. At one university, where I spent last Saturday, an Institute of Ecological Planning is being created, with faculty positions for eight ecologists, who will be attached to the Department of Landscape Architecture.

Our program in the National Science Foundation is not called *ecology*, but *Environmental Biology*. We believe we are in close touch with most of the leading practitioners and graduate teachers in the field, because we support much of their research.

Our program will have awarded grants for Fiscal Year 1968 totaling about 6.4 million dollars to about 175 investigators, nearly all of whom are college teachers and many of whom have graduate research assistants—student trainees, that is—whose stipends and research expenses are carried on their research grants. The total number of active grants of this sort in our program is currently about 600. Our program is only one of ten in the Biological and Medical Sciences Division, which granted 54 million dollars in Fiscal Year 1967. Of this, Environmental Biology granted about 5.9 million for 170 projects, about a third of it for biological oceanography and limnology and about a tenth for studies of energy flow through ecosystems. Another 5.6 million was awarded to 220 projects in Systematic Biology, a different but related program which is of extreme importance to ecology as it is to all other kinds of biology. Another 4.6 million went to Facilities and Special Programs, which supports some ship operations, some museums, some marine and inland biological laboratories, and other relatively large centers or programs, a number of which are mainly devoted to environmental biology.

Outside the Division of Biological and Medical Sciences, much of what we can call ecology (which may include but does not emphasize the *biological* aspects of environment) is supported by the various programs in the Division of Environmental Sciences. We have particularly close relations, often involving joint funding of projects, with Programs in Meteorology, Geochemistry, Geology, Weather Modification, Oceanography, and with the Office of Antarctic Programs. Thus, when NSF was asked to describe its activities in pollution research by the Research Subcommittee of the FOST Committee on Environmental Quality (Dr. Buckley's subcommittee, of which I am a member), we were able to identify about 4 million dollars worth of research support (Fiscal Year 1967) as contributing more or less directly to understanding pollution, but of this amount less than half, or 1.9 million dollars, were provided within the BMS Division, nearly all the rest being from the Division of Environmental Sciences. The Foundation's contribution of basic research support was a part of that identified by Dr. Buckley's committee as "contributing to understanding of pollution but not deliberately undertaken because of pollution." Circulation studies in estuaries provide a good example.

Our 600 or so grantees in Environmental Biology are by no means the only people doing ecology. We of course think they are among the ablest of ecologists, but we have funds for only a fraction of the good proposals that we receive, and there are many other ecologists who do not come to our Program or to NSF for support. In fact our research support is only a fraction of that which we can identify elsewhere among granting agencies.

I might begin again to describe the size of the profession by noticing that there are approximately 3,500 members of the Ecological Society of America. Remember, though, that those ecologists who are not primarily trained in *biology* are in general not members of the Society. So we can start in still a different place. The Committee on Research in the Life Sciences, set up by the NAS–NRC, and responsible to COSPUP, has been investigating the state of biology, and although the results of their survey are still being analyzed, we have some preliminary figures given us by Dr. Herbert Pahl, Executive Secretary of the Committee. At one stage in the analysis, out of 10,657 biologists who took doctoral degrees, 737 or 6.9% took their most recent degree in ecology. However, when asked what research materials they had used in their most recent doctoral training, 553 of the same ten thousand biologists said they had made "ecosystem studies," but 2,004 or 18.8% of the total said they had studied "populations of organisms." This larger group would include population geneticists and evolutionists, but these too are at least "ecologically oriented." It is interesting to notice that out of about 8,000 biologists who answered a different question, one about their current and future interests, 800 intend to change their research field. Of these 800, 74 will direct their future interests into ecology, ecology being one of the 5 major fields receiving changes of this sort. When this and much other information about ecologists and their work has been tabulated, a panel headed by Dr. Arthur Hasler will study and report on it to the Academy's Committee on Science and Public Policy (COSPUP).

Now, because we in NSF have about 600 and the Academy knows of 700, it might seem that our program is supporting most of the 700-odd ecologists who identified themselves to the NAS–NRC Committee. That this is certainly *not* the case is shown by a different survey, conducted by a group of biometeorologists representing the American Meteorological Society and assisted by a small grant from our Program. This group first queried the Smithsonian Science Information Exchange for current (late 1966) research projects in ecology. A preliminary run shook out some 14,000 projects, which were then carefully scrutinized by a group of professional ecologists and reduced to about 2,800 that were clearly ecological. Nearly every one of these, in other words, might have been proposed to NSF, and if of very high quality would have competed for the 5.6 million dollars allocated by our Program that year. Dollar amounts for all of these projects were not available, but in the attached table, summarizing these projects by agency, we see that a large number of agencies are supporting ecology. Though Interior seems to be in the lead, Agriculture and AEC are probably the real leaders: most of the projects they are supporting had not yet had dollar amounts attached to them in SIE's system. Collectively, those with known dollar amounts attached, accounted for three times as much ecology that year as NSF did. Somewhat vaguely but not surprisingly, we end up with the conclusion that there are thousands of ecologists working at thousands of projects, but it is very difficult to know precisely how many there are because the number depends on how one definies an ecologist.

As we turn to the vitally important question of training and recruitment, we must notice first that "professional ecology", if represented by a PhD. degree in ecology, would not include a large number of true professionals in agricultural science, forestry, wildlife management, or earth science, who work for a variety of agencies, local, state, and federal as well as industrial, without having needed the PhD. degree. Let us also emphasize what should by now be very evident, that ecology is a highly multidisciplinary science, so that it is often an arbitrary matter whether one calls biometeorologists, limnologists, or geochemists "professional ecologists" or not. Society affiliation helps a little, but not much. If I may cite my own case as typical, I am a member of 15 professional societies; and if society affiliation were any criterion, I could describe myself as a "professional" anything from anthropologist to zoologist. I believe my own case is typical if a little extreme; that is the way ecology is, and its practitioners *must* keep contact with several different disciplines.

In trying to answer this subcommittee's questions, therefore, it seemed essential to probe a little into the multidisciplinary nature of ecologists' training. The Study Committee of the Ecological Society had already made a survey of the 20 leading universities that train most of the PhD. ecologists in the U.S., and had come up with the pitifully small number of 112 PhD. ecologists as an average annual production. The Committee then had second thoughts and recently issued another questionnaire, this time more an opinion survey than a fact-finding operation, but this time also asking the questions about training in a different way.

A copy of the questionnaire and its covering letter are attached, with a preliminary tabulation of the first 123 responses (out of the total of 168 inquiries). Though it is preliminary and though it is only an opinion survey, the results give a very different impression of the state of ecology as a subject in our universities. They indicate that the production rate is nearer to 3,000 than to 100 PhD. ecologists (and perhaps as many as 10,000 undergraduates) *if* one counts ecologists in the ways they themselves do. They also indicate that the numbers could be at least doubled, perhaps tripled, with no major reorganizations on campuses, if facilities, stipends, and administrative support were available.

Here I want to stress that these 168 campuses are *all in the United States.* Canadian universities were deliberately omitted, but I can assure you that ecology as a profession does not forget them. In any list of, say, 50 really distinguished ecologists in North America, about half will turn out to be Canadians, most of whom had their training in Canada. Several extremely strong Canadian universities draw not only many students but many faculty members from the U.S.

To summarize what I have said so far, ecology is represented by many more professional people than is sometimes thought, a relatively large body of recruits is being trained right now, and the teachers of ecology on our campuses believe that the number of recruits could be expanded by an average of 2½ times with no substantial organization changes. In addition, there is now clear evidence that intellectual talent can rather readily be recruited when ecological projects of scope and imagination require mobilization of such talent. In other words, ecology seems to us to be in a reasonably healthy state, and ready to respond to society's needs for understanding environments in depth and detail.

To say this, however, is not to say that nothing more needs to be done. A number of new organizations and institutional relations must be develped, and a great deal of hard ecological research must be done, before we can say, as Mr. Daddario would like us to say, that ecology has an adequately strong voice in public affairs or that ecological ideas are sufficiently diffused to decision makers at all levels. In speaking briefly to some of these new plans and institutional relations, I should make it clear that I am speaking mainly as an academic ecologist, not primarily as a representative of the National Science Foundation.

I should say first that ecological research, though very good, will not be truly excellent or adequately supported until substantially increased support is available for graduate students. "My field needs more money", as I am sure I am the first to say before Congressmen, but as the "project grant system" continues and expands support to match the increasing quality of projects in science, it is on graduate research training that I place my top priorities. Present ways of providing this training through the universities are not completely satisfactory, and ecological students are tending to get the short end of such support as is available.

The time has long since passed when the "ecologically oriented" graduate student was the cheapest kind to have, because all you had to do was give him a bicycle and bench in the museum, and great results would flow from his intensive study of the "biology" of two closely related sets of museum specimens. Three kinds of new technologies have been developed in the last few years, in geophysics (such as multispectral remote sensing), geochemistry (such as isotopic tracing), and computer science, that have transformed field ecology just as biochemistry has transformed laboratory biology. One result is that ecological graduate students are the most expensive rather than the least expensive kind. Not only does their training demand very expensive instruments, but the geographic dispersedness of the subject makes it in many cases essential to send them repeatedly and for long periods to the tropics, the arctic, and many other places beyond the reach of a bicycle. Hence, for adequate research training at the graduate level sharply increased support, much of it in the form of research traineeships, is essential. There is little reason to believe that NIH will consider this kind of biology sufficiently health-related to extend its magnificent training programs to include the whole of ecology.

As to the need for ecological research, I should make it clear that no thoughtful ecologist takes the position that society can do nothing about using its environment until 25 years' more research results have accumulated and "we really know what it is we are doing." Society can not wait that long, and will not. Ecology knows a great deal right now that is not being applied intelligently, and many of the answers decision makers seek are already available if mechanisms can be found for communicating them. In fact, if the basic ideas of ecology were as completely internalized by educated persons as are the basic ideas of economics (like "the market" and "benefit-cost ratios"), much of the environmental deterioration we are all so concerned about might have been avoided before it started.

Nevertheless, ecology is only at the beginning of a new phase of discovery. An enormous amount of high-grade research needs to be done, and done quickly, before some of society's major questions about environment can be answered. What is coming to the fore is a concept of the ecosystem, and a wholly new set of procedures for studying ecosystems on a regional scale, so that the requisite research in many field projects must now be multidisciplinary in practice as well as in the library.

Much is now known about ecosystems, which range in scale from drops of water to 10-acre corn fields, and some extremely ingenious theories are available to account for the behavior of complex systems and to help model them so that their variations under experimental manipulation can be tested by the computer. These computer-simulation techniques are particularly helpful when dealing with forest stands, small lakes, estuaries, and so on which are too large to be experimentally manipulated in the usual ways. But the results of all such studies, however informative, cannot be extrapolated upward to larger patches of nature, containing more environmental and biological diversity (and especially those *containing* man and his artifacts), without loss of rigor and predictability. Ecology therefore needs to deal with systems on a large enough scale to be both meaningful and helpful, and it is for this kind of research that new modes of team work and multidisciplinary collaboration are being developed.

Some of the reasons for conducting team research on ecosystems have been spelled out in the Study Committee's plan for a national institute of ecology, on the pattern of the National Center of Atmospheric Research (NCAR). Personally I subscribe wholeheartedly to this idea. It seems to me the first really workable idea for bringing ecology to bear on major environmental problems that has appeared during my career. I recognize that it is not a panacea. "A *research* institute is not the only mechanism, or necessarily the best mechanism" for fulfilling *all* the responsibilities of ecology to public information, education and advice. Nevertheless, having talked a good deal with atmospheric scientists over many years and also during this year's term with the National Science Foundation, I am profoundly impressed by the appropriateness of the NCAR model and intend to do all I can to demonstrate its application to ecology. It seems to me there are very many points of similarity—procedural, educational, organizational, and motivational—between ecology as we see it now and atmospheric science as it was seen by a number of farsighted scientists 15 or so years ago. More than that I will not say just now, because I know that Dr. Cole will be discussing the Study Committee's plan with you this morning.

In urging the need for this new mechanism for conducting largescale team research on ecosystems, I do not want to be heard as insisting that ecology must abandon its older ways of doing things. Ecological research as conducted in hundreds of independent institutions by thousands of able scientists and their students is very good and getting better all the time. Scientists prize their intellectual independence, and that independence of inquiry must be preserved. There must always be room for the cantankerous or even misanthropic genius who will vigorously reject the idea that this research and teaching should be "programmed" by "those bureaucrats running that National Institute," or in fact programmed by any mind but his own. I say only that *some* kinds of ecology can *only* be done by well organized teams, that those kinds are among the most important as well as the most exciting kinds, and that some portion of the profession is ready and eager to conduct these kinds of ecology in the field.

Not being partial to being programmed myself, I have come rather slowly to this way of thinking. One of the main sources of my present conviction is the emerging U.S. portion of the International Biological Program, the portion that is now regarded as central and is called *Analysis of Ecosystems*. As this Subcommitee knows very well, the IBP has not sold itself equally vigorously in all quarters, and "friendly critics" have not been lacking who fear that the entire enterprise may be a gigantic boondoggle. Speaking now as an old Eagle Scout who knew what a boondoggle was before 1933, I assure you that IBP is not a boondoggle, that it is in many ways the most exciting program in natural science to appear since the IGY (International Geophysical Year), and that a very great deal of shaping, organization, scrutiny for high quality, etc., has taken place during the last few months within and around the U.S. IBP Committee.

To show where my own priorities lie within the framework of this program, and to stress the points that I think need stressing if the program is to appeal widely on its merits, I have drawn up a little statement about the IBP which is attached to this testimony. Actually, it was prepared at the suggestion of Freeman Quimby of the Library of Congress staff, and as he has now seen it for the first time this morning and as almost no one else involved has yet seen it, I ask the indulgence of the Subcommittee in placing this preliminary draft on record.

Finally, let me comment briefly on some other ideas that are circulating that are intended to increase the effectiveness of ecology in public affairs. I have tried to make it clear that I believe that ecology will acquire an appropriate voice in public affairs when it deserves one as a consequence of being better science. Much of the talk we hear—and I have probably talked as much as anyone on such matters, is simply not effective because, as L. B. Slobodkin says, it "tends to substitute purpose for action". Slobodkin warns us about "the satisfying sense of being unable to take specific action because of a malicious, or at least uninformed, opponent or class of opponents".

I believe most ecologists would like very much to see such and advisory group as the proposed Council of Ecological Advisors or Council on Environmental Quality attached to the Executive Office of the President, providing genuinely informed advice on environmental programs in parallel to that given by the Council of Economic Advisors. Several bills providing such councils are now being considered by this Congress and this Subcommittee, and I think I should say very little about any one of them because I tend to favor them all rather indiscriminately but do not feel professionally qualified to argue the finer points of managerial science with advocates of one or another council.

In other words, ecologists, who are citizens first, are natural scientists second, and political scientists a very poor third, so that their role in advice-giving councils needs to be carefully delimited to the areas of their professional competence. By no means do I say that ecologists should not worry about such matters, for they must and will, but I suggest they will meet their political objectives faster if they get on with their own job of doing better ecology.

THE ECOLOGICAL SOCIETY OF AMERICA.

To a Selected Group of U.S. Ecologists:

We are sorry to inflict another questionnaire on you, but we think this one is important to you as an ecologist, and it won't take much of your time. Please read these questions with care, discuss your answers with others on your campus if you feel you need to, but return the questionnaire promptly, i.e. within a week. We will collect most answers by telephone, as we want 100 percent response, but if you take a little time to consider your answers first the telephone inquiry can be efficient as well as thorough.

The immediate purpose is to prepare ourselves for a congressional inquiry into the state of ecology as a profession. Representative Daddario's Subcommittee on Science, Research and Development is conducting a new series of hearings on environmental problems, and E. S. Deevey and I are invited to testify for ecologists. In a letter written during the last session, Mr. Daddario doubted that ecology is yet able "to become an umbrella science for greatly expanded research effort", but praised the Ecological Society's activities that "involve ecology in public affairs as well as the education of ecologists and the infusion of ecology in general education at all levels."

We find our own information about research training, is very deficient. The general surveys available (including the one now being assembled by the NAS/NRC Committee on the Life Sciences) do not adequately identify *ecology* as a separate subdivision of biology, owing to admixture with systematic, evolutionary, and physiological biology. Moreover, an outstanding property of ecological education is its interconvertibility; under certain circumstances—especially assuming the enlarged responsibilities Mr. Daddario is concerned about—meteorologists, geochemists, oceanographers, and behavioral biologists are all, or can easily become, ecologists, and economists, anthropoligists, and other kinds of social scientists should also be considered. Our questions are designed to probe into this interconvertibility. We hope that a quick survey will produce more meaningful estimates of the numbers of ecologists than a more highly organized and costly survey that fails to ask the right questions of the right people.

You have been selected, probably somewhat arbitrarily, to speak for ecology *on your campus*. Some of you are departmental chairmen, but our idea is to ask ecologists, not administrators. As a professional, you yourself exemplify the multidisciplinary aspect of the subject that we want to emphasize, and we cannot be sure that that is true of chairmen, deans, and registrars.

It will not be possible for you to be accurate in your assessment of which students are potential ecologists and which are not; the best approximation you can make is the one we want. Obviously, you will have most trouble when you look outside your own department. The best guideline we can think of to help you is *potential research collaboration and orientation*. If this student, with this kind of training is a potential collaborator with you and other ecologists, not necessarily in what you are doing now, but in any ecological project in which you might join, count him as an "ecologist".

We are interested in *current* numbers students being trained, and suggest the last five years as giving appropriate averages; but if dramatic reorganizations in your campus make the future training capacity look very different, use the next three years as the time-period for your average estimates.

Please give the matter some thought, return the questionnaire in the enclosed envelope, and be prepared for a telephone call in the next week or so.

Cordially,

LAMONT COLE,
Chairman, Study Committee.

INSTITUTIONS WITH GRADUATE PROGRAMS

STUDY COMMITTEE, ECOLOGICAL SOCIETY OF AMERICA QUESTIONNAIRE: TRAINING OF ECOLOGISTS

[Numbers are estimates only. Your replies will de tabulated but not identified as yours]

	Your department	Other biological departments[1] (how many?)	Earth science departments	Social science departments	Others if any[2]	Total
How many students are currently receiving training as ecologists on your campus?						
Ph. D. level (not counting attrition; estimate average number of Ph. D.'s per year)	743 (82)	1,288 (50)	201 (36)	230 (20)	110 (23)	2,572
Terminal MS level (average number of MS candidates who enter professional status without further academic training)	636 (90)	848 (54)	160 (43)	287 (26)	134 (22)	2,065
Undergraduate majors (those who enter graduate or professional status in ecology on award of B.A. or B.S. degree)	1,852 (79)	2,374 (42)	411 (37)	1,408 (25)	176 (20)	6,221

[1] E.g., wildlife, fisheries, forestry, agriculture, botany, zoology, microbiology, physiology, biochemistry, biophysics, entomology, and oceanography.

[2] You may want to consider architecture, city planning, of even engineering.

Note: 105 institutions responded to this questionnaire.

Check if applicable

This institution has no graduate programs.

There are graduate programs but not in ecology.

Assuming no major reorganization or expansion, and assuming an adequate supply of eligible students, by what factor could these numbers be increased in the next five years? 1.0, 1.5, 2.0, etc.) *2.5* (*14*)

Which *one* of the following is the major factor that may prevent such an increase?

1. Inadequate direct (stipend) support for ecology students, 9.
2. Inadequate facilities, including space, laboratories, and libraries, 14.
3. Inadequate or unbalanced faculty positions in ecology, 7.
4. Lack of vision or ecological orientation or part of administration, 7.
5. Supply of eligible students, contrary to assumption above, is not expansible on this campus, 6. (We're scraping the bottom of the intellectual barrel right now").

Is there on your campus a cross-departmental organization 'Institute or Center for Environmental Studies, degree program in ecology, oceanography, conservation, etc.) that coordinates ecological research and/or training?

1. No. 17.
2. No, and we won't have one if I can prevent it. 1.
3. No, but we are working on one. 10.
4. Yes, but it is largely on paper; i.e. a committee. 2.
5. Yes, but it is too new to appraise. 3.
6. Yes, and it is working reasonably well. 7.

INSTITUTIONS WITH NO GRADUATE PROGRAMS

STUDY COMMITTEE, ECOLOGICAL SOCIETY OF AMERICA QUESTIONNAIRE: TRAINING OF ECOLOGISTS

[Numbers are estimates only: Your replies will be tabulated but not identified as yours]

	Your department	Other biological departments[1] (how many?)	Earth science departments	Social science departments	Others if any[2]	Total
How many students are currently receiving training as ecologists on your campus?						
Ph. D. level (not counting attrition; estimate average number of Ph. D.'s per year)						
Terminal MS level (average number of MS candidates who enter professional status without further academic training)						
Undergraduate majors (those who enter graduate or professional status in ecology on award of BA or BS degree)	209 (24)	154 (15)	22 (9)	78 (7)	3 (1)	466

[1] E.g., wildlife, fisheries, forestry, agriculture, botany, zoology, microbiology, physiology, biochemistry, biophysics, entomology, and oceanography.

[2] You may want to consider architecture, city planning, or even engineering.

Note.—18 institutions responded to this questionnaire.

Check if applicable

This institution has no graduate programs. ☐

There are graduate programs but not in ecology. ☐

Assuming no major reorganization or expansion, and assuming an adequate supply of eligible students, by what factors could these numbers be increased in the next five years? (1.0, 1.5, 2.0, etc.) *2.74* (*98*)

Which one of the following is the major factor that may prevent such an increase?

1. Inadequate direct (stipend) support for ecology students—42
2. Inadequate facilities, including space, laboratories, and libraries—43
3. Inadequate or unbalanced faculty positions in ecology—30
4. Lack of vision or ecological orientation on part of administration—14
5. Supply of eligible students, contrary to asumption above, is not expansible on this campus—15 ("we're scraping the bottom of the intellectual barrel right now")

Is there on your campus a cross-department organization (Institute or Center for Environmental Studies, degree program in ecology, oceanography, conservation, etc.) that coordinates ecological research and/or training?

1. No—14
2. No, and we won't have one if I can prevent it.
3. No, but we are working on one.—30
4. Yes, but it is largely on paper; i.e. a committee.—18
5. Yes, but it is too new to appraise.—20
6. Yes, and it is working reasonably well.—15

CURRENT SUPPORT FOR ECOLOGY (DECEMBER 1966)

SCIENCE INFORMATION EXCHANGE

[Prepared for American Meteorological Society Study Group on Bioclimatology]

Supporting agencies	Number of grants without funds	Number of grants with funds	Amount of grants with funds
Agriculture, Department of	868	92	$1,065,586
Alabama, State of	7		
Alaska, State of	1		
American Association for Advanced Science		2	203
American Cancer Society		1	6,500
American Philosophical Society	1	1	1,000
Airzona, University of	3	2	7,000
Arizona, State of	5		
Arkansas, State of	11		
Atomic Energy Commission	72	28	1,007,561
California, University of	2	2	25,500

CURRENT SUPPORT FOR ECOLOGY (DECEMBER 1966)—Continued

Supporting agencies	Number of grants without funds	Number of grants with funds	Amount of grants with funds
California, State of	96	1	$33,000
Canada, Government of	1		
Colorado, University of	6		
Colorado, State of	6		
Commerce, Department of		2	7,752
Connecticut, State of	1		
Delaware, State of	1		
Florida, State of	21		
Ford Foundation	1		
Georgia Institute of Technology	1		
Georgia, State of	22		
Guggenheim, J. S., Memorial Foundation	1		
Hawaii, State of	10		
HEW PHS Bureau of Disease Prevention and Environmental Control	1	25	674,992
National Institutes of Health		67	1,682,433
Idaho, State of	9		
Illinois, State of	6		
Indiana University	1		
Indiana, State of	22	1	18,000
Interior, Department of	109	704	4,324,028
Iowa State University	2		
Iowa, State of	4		
Kansas, State of	7		
Kent State University	2		
Kentucky, State of	5		
Louisiana, State of	14	8	11,500
Maine, State of	1		
Maryland, University of	1		
Maryland, State of	3		
Minnesota, State of	25		
Mississippi, State of	7		
Missouri, University of	2		
Missouri, State of		4	19,400
Montana, State of	6		
Montana, University of	1		
National Audubon Society		1	5,000
National Science Foundation	1	202	3,237,188
Nebraska, University of	1		
Nebraska, State of	5		
Nevada, State of	1		
New Hampshire, State of	2		
New Jersey, State of	7		
New Mexico, State of	8		
New York, State University of	5		
New York, State of	44		
No formal support	1		
North Carolina, State of	14		
North Dakota, State of	2		
Ohio, State of	10		
Oklahoma, State University	2		
Oregon, State of	46	6	69,000
Pacific Northwest Power Co		1	24,000
Pennsylvania, State of	10		
Portland General Electric Co		2	31,500
Puerto Rico, Commonwealth of	3		
Purdue University	1	1	1,500
Research Corp		1	8,000
Rhode Island, State of	2		
Rockefeller Foundation		5	122,643
Sigma Xi, Society of		10	3,850
Smithsonian Institution	6		
Social Science Research Council	1		
South Carolina, State of	6		
South Dakota, State of	9	1	16,000
Southern Illinois University	1		
Tennessee Valley Authority	1	3	25,000
Texas A & M University	1		
Texas, State of	31		
Utah State University	13	1	1,100
Utah, State of	7		
Veterans' Administration	1		
Virginia Polytechnic Institute	3		
Virginia, State of	16		
Washington, State of	8		
Wisconsin, State of	13	2	13,568
Wyoming, State of	3		
Total	1,650	1,176	12,442,804

WHY AN INTERNATIONAL BIOLOGICAL PROGRAM?

For all animals and for man, today's material resources are tomorrow's garbage, and vice versa. Waste, therefore, does not exist. Living systems move matter around, into and out of many sources and sinks, but they do not create matter, or destroy it. Eventually, plants remake what we call resources out of what we call garbage. The energy they need to do this is captured from sunlight.

Most resources used by man are chemically reduced. Food, iron, and gasoline are examples. When they are used, oxygen is added to their molecules, and they gain weight. Therefore the more resources are used, the faster the total weight of garbage increases. Fortunately, in turning oxidixed compounds that were garbage into reduced compounds that are resources, plants restore the oxygen to the atmosphere.

Human societies are now so large, so complex, and use resources so rapidly, that they are in danger of drowning in their garbage. The problem is inescapable; there is no rug under which it can be swept. All sinks are temporary; like cesspools, they have a way of becoming septic when overloaded. "Waste resources" have seriously polluted the Great Lakes, and even the ocean cannot process all the garbage it now receives.

Most men understand these matters in principle, to detail, nobody understands them well enough. Partly, this is because living systems are amazingly complex, and are turning out to be interlocked in unexpected ways. In addition, the pace of technological progress has intensified the need for understanding. Human ingenuity creates so many "new" resources, and they become garbage so quickly, that old ways of handling garbage can no longer be counted on. Meanwhile, the old familiar pollutants—silt in our reservoirs, manure on our farms, carbon and sulfur compounds in our air—pile up on an unprecedented scale, and overflow the sinks that used to contain them.

When garbage is smoothly converted to resources, we speak of a system's "output" as "production". When interruptions occur in the same systems, we call the pileups "pollution", and notice that "production" is declining. Pollution, then, is deflected production. It can be channelled or controlled, but as every material pollutant is a potential resource, none can be eliminated entirely. Pollution is the internal friction of productive systems, part of the cost of maintaining output.

The International Biological Program is devoted to understanding the biological basis of human welfare. Because it is an international research program operated in more than 60 countries, it emphasizes those kinds of biology that demand information from a global "field." These include human genetics and nutrition, human responses to stressful environments, transport of airborne spores and pathogens, colonization of islands and of disturbed environments, and other not yet fully formulated. None is more important than the one the US–IBP Committee has chosen as central: Analysis of Ecosystems. It is central because it focuses on man's central problem, as a dweller in environments: the relations, in depth and detail, between pollution and production.

Analysis of Ecosystems is not less international than other components of IBP. In the United States, however, it differs both in scope and in emphasis from its counterparts in other countries. In much of the world, where more food is man's paramount need, the emphasis logically falls on production. In the United States, as in other developed countries, production has been reasonably adequate, at least up to now, and the emphasis falls instead on pollution. In the ecological view, however, these problems are inseparable. Today's productive systems are always polluted in some sense; it is *intensified* pollution that short-circuits production, behaving exactly as a cancer in the system. The objective of Analysis of Ecosystems is to understand living systems well enough to recognize such cancers before they start.

EDWARD S. DEEVEY.

ADDITIONAL VIEWS SUBMITTED BY DR. JOHN E. CANTLON

I should like to take as a point of departure a recent remark made in a body of scientific consultants. This group was examining a series of possible avenues that might yield useful approaches for meeting our burgeoning environmental problems. One scientist's remark brought the discussions to a climax.

"I keep hearing strong pleas for encouraging the investigation of natural purification phenomena, and of the need for more and better ways to halt increasing pollution. Why aren't we concentrating our scientific efforts on increasing tolerance to pollution?"

In a quick assessment of the matter this does indeed appear to be an oversight. Yet with some thoughtful reflection we can see that this rather widely held question is symptomatic of our past aimless drift of accelerating environmental degradation. It starts from two false premises: a) that the forms of pollution we now suffer under are essential and inescapable byproducts of modern industrial living, and b) that man and a very few domestic plants and animals are the only creatures on earth we need worry about.

Setting aside my strong moral and ethical reservations over the latter, let us consider the logic of these two premises.

It has been stated many times that pollution is really one or more resources out of place. Sewage-contaminated water is not only degraded water, it also represents potentially usable inorganic nutrients. Further the heat pollution from our power plants might with a bit of creative engineering be usable in one or more other phases of the water pollution problem. A systems look at the overall pollution mix could well yield real technological breakthroughs intrinsically useful quite apart from their improvements in environmental quality. We need to reach free of the narrow technological strait-jackets in which our current crop of problem solvers was trained. We need not tolerate existing pollution—we clearly should not expend scarce public funds to increase tolerances to today's stupidities.

Generating even more trauma in ecologically aware persons, however, is the widely-held nonsense that man and a veritable handful of domesticated plants and animals are all that are essential to the ecosystems that sustain man. If this were true *we* might learn to love pollution, breed our domesticants to resist it and evade forever the responsibility and expense of halting the accelleration in the fouling of our nest.

A moment's reflection suggests clearly that we cannot have the option of permitting the demise of large numbers of the earth's essential but poorly known organisms. A rather spine-chilling observation is that no man, no group of men, can tell us this moment how many of the earth's species constitute the irreducible minimum biota to keep our biosphere functioning and healthy. To think we could breed resistance to any list of pollutants in any significant number of these species—even if we knew which ones to select—is patently absurd.

How is it possible for otherwise knowledgeable scientists to be unaware of any hazard stemming from a pollution-stressed and pollution-reduced earth biota? Why are they so confident that no damage can be incurred to essential organisms such as N-fixing microbes? Largely, I suppose, it's the appearance of having gotten away with it up to now. They need to be cautioned, however of the rapidly shifting balance between man-generated systems of less than 30 years old, and ecological systems that have survived a valid test of time. There is a great deal of difference in the potential danger to the overall system of farms separated by fence rows and woodlots as opposed to blocks of hundreds of square miles containing a single variety of wheat and sustained by an ever-lengthening list of pesticides, the latter of which may escape to damage organisms at some distance from their point of application. Also, a lonely camper urinating behind a tree is a far cry from the chain of urban complexes utilizing the same river for sewage disposal, generator cooling, drinking water and allowing their urban pest control chemicals to move down the storm drains into the same river. We now approach a scale of operation that does indeed endanger other species. If we know they aren't now essential, and if we are certain we will *never* profit from the genetic information' they contain, we might justifiably swap our freedom to pollute against their loss. To permit extinctions unmonitored and in complete ignorance of the creature's genetic assets borders on lunacy.

How have we learned so much only to become so ignorant? Scientists and engineers are often more coldly willing to take the risks in such trades than an uneducated person. Something is drastically wrong with our priorities in education.

Many of us have noted with dismay that while our public schools *require* courses in how our governments function, in how our economy functions, and even in how the student's own body functions—none (to my knowledge) require courses focused on how the ecosystems that sustain society function. Couple this with the ever-increasing number of lifelong urbanites in our society and we get a hint of the educational displacement.

In my own opinion we ought to require elementary training in systems ecology for all of our high school graduates. We surely need it for our engineers, for all high school teachers, home economists, and the scientists in agriculture, industry and medicine.

However, let me emphasize that the ecologists don't have all the answers. They happened to have been the present custodians of what was left in the classical field of natural history after the taxonomists, geologists, engineers, chemists and physicists departed for their own reductionist worlds. By taking apart into smaller and smaller pieces their particular slice of old "Ma Nature", they have given us the glories of the scientific age, atomic energy, the DNA code, how to convert fossil plant debris into magic white fluid that propels a couple of tons of steel and rubber and one man across the landscape at a mile a minute—and the solid state electronics that led to modern computers. Meanwhile back in nature, the ecologists have profited from their reductionist brethren and began using isotopes to get at the transport systems showing how resources are transferred between species. They learned to utilize the computer to handle the vast scales and noisy world deliberately left behind by the ever more narrowly trained other scientists. They adopted the systems approaches developed by engineers, some of whom were learning the complex art of putting a man in a sealed life support system for interplanetary travel.

Now the ecologists—who a short 20 years ago nearly drummed out of their society those colleagues interested in man's problems—have come to realize that their left-over science is a pivoted science for man. Not all ecologists are happy about this. Many wish the engineer would learn enough ecology to stop making fools out of themselves and costing future generations untold misery from bad ecological judgment in unnecessary drainage projects, faulty waste disposal systems, air polluting combustion and processing systems etc. These ecologists like their fellow-scientists in other fields ask only to be left alone to do better ecology. If the lately discovered worth of their science leads more of the brighter young men to adopt it for a career, or leads congress in its wisdom to view with favor agency proposals for ecological training for the general public, they would be content.

Many of us, however, feel that the time is short, the number of adequately trained ecologists too small, the avenues likely to benefit from ecological contributions are too many to leave matters stand as they are now.

If sputnik jarred the United States into realizing Russia had slipped unheralded and unnoticed into first-rate scientific stature, perhaps our impending environmental flap could be the ecological equivalent. Crash programs are always wasteful, but unfortunately in our Madison Avenue conditioned society, they are more likely to derive public support than a calm steady growth. I trust this committee in its wisdom will find a suitable route. I would like to suggest the following:

1. Fundamental research on natural purification processes be encouraged to the extent that these fields will be in as favorable a position to draw scientific engineering talent as say the space program or internal medicine; e.g., (*a*) atmospheric particle scrubbing; (*b*) biological uptake of inorganic nutrients from aquatic systems; and (*c*) inorganic nutrient retention by terrestrial systems.

2. That modelling and computer simulation of natural and man-made systems be encouraged so that we may anticipate which components in such systems are apt to be most sensitive to pollution stresses and which most important to the natural purification processes.

3. Perfect micro-cosms of high complexity and reproducability for use in meaningful bioassay in pollution studies.

4. Initiate a program designed to examine the genetic and ecological information contained in the earth's ecosystems for potential uses in pollution control, a counterpart to the USDA's plant introduction program.

5. Consider the possibility of assisting in the birth of a national unit that could assemble problem solving arrays that do not live on after their problem is solved. One in which talent moves from problem to problem and back to the higher educational system both for helping keep the education systems tuned to current problems and for the renewal of talent. I think of the I.G.Y., and possibly the I.B.P. models, but the Weather Modification Commission and the NSF's participation it might also work. If the NSF had a separate major unit comparable to its present semi-separation of the Education Divisions from its Research Divisions, perhaps called Engineering and Applied Sciences, it might successfully undertake such a role. This unit, like the current Education Divisions, would use criteria beyond scientific merit in its decisions. Further, it should be given a charge to ellicit proposals from the best talent that can be interested in a problem the division chooses to pursue. Existing national laboratories and Industrial laboratories from the private sector should not be passed

over if the academic science community lacks comparable problem-solving potential. Problems and approaches not yielding rewarding results after a reasonable time should be discontinued but certain long range research should be encouraged. The unit should not become the national monitoring agency for any environmental condition but might perfect techniques or engage in research necessary to establish whether such monitoring might be prudent. My personal view is that in most cases it should not create new national facilities except where a reasonable case is made that other agency goals preclude effective management of the necessary unit.

6. An inter-agency committee alone is quite sure not to perform a lead role in finding imaginative new aproaches to environmental problems, and is unlikely to be very effective even in controlling its member agencies' current bad practices.

7. Consider seriously the wisdom of setting up a council of ecological advisors for the executive branch of government, as has been proposed by several bills over the past year or so. A word of caution here. Advisory boards are only as good as the people on them. Several bodies concerned about the environment have appointed panels of prestigious scientists, engineers and administrators, none of whom had a clue as to how an ecosystem functioned—some were even unaware of the term. One would hope that ecologists would have an opportunity to make an input to such a potentially important function.

EXECUTIVE OFFICE STUDY

(THE FOLLOWING STUDY WAS FURNISHED TO THE SUBCOMMITTEE SUBSEQUENT TO ITS HEARINGS ON ENVIRONMENTAL QUALITY)

EXECUTIVE OFFICE OF THE PRESIDENT, OFFICE OF SCIENCE AND TECHNOLOGY

MARCH 1968.

The attached report was prepared in response to a request by the President to the Directors of the Office of Science and Technology and the Bureau of the Budget to recommend how the Federal Government may best direct its efforts toward advancing scientific understanding of natural plant and animal communities and the ways in which they are influenced by man and his activities.

This report emphasizes the need to conserve and to increase our understanding of our unspoiled wildlands—forests, grasslands, deserts, streams, and lakes.

The report proposes

setting aside on Federal lands additional natural preserves for scientific purposes, and

conducting surveys and research so that we will understand better the impact of environmental changes.

Additional information is available from Dr. Donald R. King, Executive Office of the President, Office of Science and Technology, Executive Office Building, Washington, D.C. 20506; 395–3516.

DONALD F. HORNIG, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
OFFICE OF SCIENCE AND TECHNOLOGY,
Washington, D.C., January 24, 1968.

Memorandum for the President.

Subject: Advancing scientific understanding of natural plant and animal communities.

At the time of your February 1965 Message to Congress on Natural Beauty, you instructed the Directors of the Office of Science and Technology and the Bureau of the Budget to recommend how the Federal Government may best direct its efforts toward advancing scientific understanding of natural plant and animal communities and their interactions with man and his activities.

Our review indicates that no one agency now has or should have exclusive jurisdiction in this area. Ten agencies are now carrying on activities—as an essential part of their respective missions—that are related to scentific understanding of natural plant and animal communities or "wild lands" which include forests, grass lands, deserts, swamp lands, alpine regions, lakes and streams, marine systems, and small semiwild areas within cultivated lands. Understanding of these areas is an integral part of the *total* effort to understand the complex interrelationship among living things and the interactions between them and their physical environment. This is the science of "ecology."

Coordination and communication among agencies and with the general scientific community is needed to assure that essential work is carried on, and undesirable duplication is avoided.

We recommend that

the Office of Science and Technology assume responsibility for maintaining overview of this area and

assure necessary coordination among agencies and with the science community.

The Office of Science and Technology staff can call on such groups as committees of the Federal Council for Science and Technology, panels of the President's Science Advisory Committee, professional societies, and the academic community—for advice and assistance.

The above conclusions are based in part on the recommendations of a panel of experts from Federal agencies assembled by the Office of Science and Technology. The panel made recommendations dealing substantively with areas of potential action and with the question of how the Federal Government may best direct its efforts related to the understanding of natural communities. A report based on the panel's findings is attached. The report recommends:

designation of additional protected natural areas for scientific purposes;

expansion of research, including cooperative studies of a limited number of large ecological systems;

expansion of monitoring and survey programs to measure the impact of environmental changes; and

improvement of ecologically-oriented training and education programs.

We believe the recommendations require close attention by the concerned agencies. We plan to make the report available so that agencies may review their programs in light of the recommendations, and consider how they might emphasize and reorient activities that contribute to advancing our understanding of natural plant and animal communities and their interactions with man and his activities.

The Bureau of the Budget makes no recommendations for the commitment of funds for new programs. Such decisions can be made only after careful consideration of agency proposals within the context of fiscal policy prevailing at the time.

CHARLES L. SCHULTZE,
Director, Bureau of the Budget.
DONALD F. HORNIG,
Director, Office of Science and Technology.

ADVANCING SCIENTIFIC UNDERSTANDING OF NATURAL COMMUNITIES

In his message to Congress on Natural Beauty on February 8, 1965, President Johnson asked the Directors of the Office of Science and Technology and the Bureau of the Budget to recommend *how the Federal Government may best direct its efforts toward advancing scientific understanding of natural plant and animal communities and their interactions with man and his activities.*

Natural plant and animal communities are important in rendering material services indispensable to the welfare of man as well as in satisfying aesthetic and recreational needs. They are the least modified ecological[1] systems. They constitute the so-called "wildlands," and include forest, grasslands, marine systems and small semi-wild areas within cultivated lands. The condition and productivity of these natural systems are highly relevant to all segments of human society. The production of food from the sea, food and other products from livestock on natural grasslands, timber from forests, and wildlife for recreation; the regulation of water run-off and maintenance of domestic water supplies; and the cleansing of air are examples of direct benefits of human society. On a larger scale, natural communities play an important role in removing carbon dioxide and releasing oxygen on land, in freshwaters and in the oceans.

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[1] Ecology is the science concerned with the interrelationships among living things and the interactions between them and their physical environment. Thus, ecology involves the interrelationships of biology and the environmental sciences such as meteorology, geology, and hydrology. Applied ecology includes practices of forestry, agriculture, the conservation of desirable nondomestic plants and animals and the control of undesirable life forms.

Natural communities are part of the very complex environment in which man lives—one in which so many factors are interrelated and inter-dependent that it is often difficult to determine what is cause and what is effect. The problem man faces is how to cope with this tangled web and extract the resources needed for his welfare without impairing the system that sustains him.

It is difficult, if not impossible, to divorce the need for programs pertaining to natural communities from the total effort in ecology. Accordingly, this report treats natural communities in the context of a broader ecological effort.

The first section of the report describes activities that are needed to advance scientific understanding of natural plant and animal communities and their interactions with man. It also describes needs for protected natural areas for continuing study; and national needs for research, surveys, and education. Current activities of federal agencies are discussed in the second section. A third section includes specific recommendations for action by the Federal Government.

I. FINDINGS AND NATIONAL CENTER NEEDS

Recent increases in the human population and advances in technology have resulted in an increasing number of environmental changes. A considerable body of knowledge of ecological relationships has been developed and constructively brought to bear on optimizing these changes. Too often, however, there is inadequate information about them to develop comprehensive judgments regarding the full extent and manner in which they are advantageous or detrimental and some of the changes are clearly unfavorable. Also, conflicts frequently arise among man's multitude of purposes. These conflicts demand an increasing amount of knowledge to provide the basis for sound decisions; e.g., decisions to whether areas of land should best be used for economic or aesthetic purposes, the extent and form in which pollutants may be introduced into the environment, and the extent and procedures by which the weather may be modified without unfavorably influencing the environment.

Much is already known, of course, about natural communities; some of it learned in studies of other environments, some in response to urgent practical needs and a goodly share gathered in response to purely scientific curiosity. But there remains a need to more fully understand the contributions these areas can and do make to the national welfare.

The following discussions outline the specific national needs for improving our scientific understanding of natural communities.

Protected Research Natural Areas

In ecological studies of natural plant and animal communities, field areas are needed as outdoor laboratories. A series of land and water research reserves—established in such a fashion as to provide protection for extended periods of time—is essential. The series should include examples of all important natural ecosystems, some available only for observation; others for manipulation. A joint effort by the Department of Agriculture and the Department of Interior (with AEC and Department of Defense cooperation) has already resulted in designation on Federal Lands of 336 areas that are available for observational studies. Additional locations will be needed to obtain representation of all ecological types.

Research

More research on environmental matters is needed. In the United States this is not primarily because new problems have arisen, though there are many, but because of the new, enlarged scale on which the old problems—subsistence, health, and the adjustment of population to resources—must now be faced. For example, sulfur bacteria and other decomposers play a role in the economy of nature that is now only dimly sensed; interference with it was inconceivable a generation ago. The oxygen content of the atmosphere, on which all human and animal life depends, is probably regulated by the combined activities of sulfur bacteria and green plants, neither being more important than the other. But the bacterial fraction, being less understood, is more open to disastrous interference by some environmental pollutant.

As previously indicated, we need to improve our understanding of the processes by which natural plant and animal communities survive and change and interact with man. Not only does optimum management of natural communities depend upon such knowledge, but also management of cultivated lands and fisheries can be improved by such understanding. Scientific team efforts are required to answer many of the important ecological questions. Research by biologists, physical and social scientists, and engineers at many locations is needed to develop improved methods and practices which will assure protection and proper utilization of natural communities.

Research principally in universities, the Federal Government and private foundations has contributed much to current understanding of natural systems, but in terms of foreseeable needs our knowledge must be greatly increased.

Studies conducted or sponsored by many government agencies are mainly directly at "economic species"—those most directly useful or harmful to man. These studies fall short of telling us what happens to the innumerable other species involved in biologically indispensable functions.

Understanding of biological processes at the individual, species, population, community, and ecosystem levels of integration is basic to their manipulation in man's best interests. Federal agencies should consider (1) increasing their ecologically oriented research activities along the lines of their specialties; (2) developing a concerted integration of effort among the agencies; and (3) lending their strong support, professional talent, and other resources in interorganizational efforts with universities, private corporations, and state agencies in the advancement of scientific understanding of natural communities. The general objectives of a needed research effort are described by four general headings.

Fundamental processes operating in and affecting plant and animal communities.—There is need for an improved understanding of the fundamental structure and the processes of natural communities which govern the development, size and fluctuations of their plant and animal populations. Additional information is needed about the mechanisms that control energy flow and organic matter production in plant and animal communities. There is also need for studies on the effects of natural and man caused influences on the condition and functions of these communities.

The information obtained would be useful in (a) maintaining the diversity and stability of natural communities; (b) predicting the influence of environmental alterations; (c) deriving principles useful in crop, domestic animal and fish production, and (d) arriving at optimum management techniques for most effective utilization of our wildlands.

Impact of plant and animal communities on man.—Additional information is needed about the role of natural areas in maintaining the equilibrium of the earth environment, and toward improving our understanding of the indispensable services rendered to man by the natural biota. Examples of such services are the uptake of carbon dioxide and the release of oxygen by plants, and the cycling of water and essential mineral nutrients.

There is also a need for studies of natural communities to determine their role in harboring organisms harmful to man and to identify plant and animal species which may have potential usefulness for him.

Natural areas are also major sources of recreational aesthetic enjoyment. Additional information is needed to determine how opportunities for public use of these areas can be enhanced, while their beauty and utility are retained.

Impact of man on plant and animal communities.—Improved understanding is needed of the purposeful and inadvertent modifications of natural communities caused by human activities. Our society is increasingly the source of major stresses on natural communities. It is imperative that we gain understanding which will enable us to protect, utilize and enjoy these areas.

Research is needed to find ways to alleviate or rectify any undesirable consequences of environmental alteration resulting from such things as weather modification, industrial and agricultural practices and waste disposal. Some innovations could be mutually beneficial to man and natural communities.

Methodology, instrumentation, and taxonomy.—Better techniques are needed to enable more accurate observation and sampling of organisms under various environmental conditions. Improved systems and instrumentation for sampling and analysis of biological, chemical, and physical processes in natural environments are also required.

Accurate taxonomy and descriptive ecology are essential foundations for ecological investigations, for other types of biological research, and for bioenvironmental surveillance. Detailed life histories are known for a relatively small proportion of the species of organisms even among those which are of direct importance to man. Several taxonomic specialists may be required for a single ecological study requiring identification of a large number of species.

Surveys

Comprehensive data are needed about the nature, frequency of occurrence and geographic distribution of living things and other environmental components comprising natural communities.

Broad scale studies.—Additional and more complete information is needed for national and regional inventories and descriptions of such things as soil, water, fish, wildlife, timber, range grasses and other vegetation. Several of these subjects for surveys are primarily found in natural areas or have their chief origins in them.

Localized benchmark studies.—Comprehensive documentation of the nature, abundance, distribution, diversity and condition of the components in a limited number of representative areas is needed to provide points of departure for measuring future changes in natural communities. Data from detailed benchmark studies provide a basis for further programs in research and monitoring and comprise an inventory of the related factors in a functioning natural system. From the standpoint of research they are points of departure for studies ranging from such basic aspects as measurement of energy flow within undisturbed natural systems, to providing a basis for assessing the long term effects of environmental manipulation e.g. existing weather modification programs. As an essential prerequisite for monitoring, benchmark information is the "ground truth" with which the impact of expected or unanticipated environmental changes can be compared.

Monitoring.—Monitoring of all relevant biological and environmental components of representative natural community areas is needed. Work should be conducted in both undisturbed and modified areas. Favorable and unfavorable changes should be noted over time and trends identified. Additional information is needed about the effects and duration of natural biologically—and environmentally—induced changes in plant and animal communities and man-induced changes resulting from management practices and other activities.

Information from monitoring has great utility in research to assess cause and effect relationships for changes in nautral communities.

Education

As we recognize new and growing environmental problems associated with our rapidly advancing technological society, it is clear that there is a shortage of "ecologically oriented" scientists concerned with understanding natural ecological systems.

Ecology, more than most fields, depends on people trained in a wide variety of sciences, but trained to be conscious of interfaces.

Well-educated scientists are urgently needed in vegetation science, the dynamics of animal populations (from insects to whales), and ecosystem oriented ecology. Highly trained technicians are required to support research scientists. Much emphasis in the biological sciences in recent years has been placed on the molecular level, but the higher levels of biological integration have been seriously neglected. It is now recognized by the scientific community and society that one of the significant needs of our time is for scientific understanding at these higher levels, including the organization of human societies and their total environment. The understanding of natural plant and animal communities is a part of the knowledge required.

The need for an increased educational effort extends from kindergarten to the graduate level. An appreciation of nature is highly important to successful careers dealing with natural communities, and this element is acquired largely through early experience in the development of an individual. While the major need is for higher education, the elementary and secondary levels cannot be neglected.

II. ACTIVITIES OF FEDERAL AGENCIES

This report includes information about the types and levels of Federal activities contributing to understanding natural plant and animal communities. Most government agencies are concerned in some sense with man-in-environment, and there are few if any aspects of society and culture that cannot be described as ecological by someone. A rigorous attempt was made to confine the inquiry to wildlands, to biological and closely related physical science, to native or indigenous species, and to natural rather than artificial systems. Environmental programs largely or solely concerned with the physical or the social environment were excluded at the outset. So were activities related only to intensively managed or man-created environments, such as cultivated fields and urban areas. But much work carried on in such areas is directed to fundamental ecological processes, and the results can be and are being extrapolated to natural communities.

It is likely that agencies, in responding to the inquiries, interpreted the "ecological" aspects of their missions rather generously. Some subjective judgments also are inherent in interpreting and categorizing the responses, implying that a general, rather than literal, assessment of the data is appropriate. At any rate, by almost anyone's definition, ten [3] agencies of the Federal Government support work that contributes to the understanding of natural plant and animal communities and their interactions with man. And, under their interpretation of what that understanding requires, the total expenditures in this area were about $162,422,000 during FY 1965 and $175,355,000 during 1966.

The major share of these expenditures was on research concentrated on individual species of plants or animals, or populations of these species, and on surveys which provide data about how much of what is where. The species studied were largely those that are pests of man or that he uses directly for food, or fiber, or recreation. Much of the knowledge gained from such studies is useful in understanding natural plant and animal communities, and some of it would in fact have to be gathered specifically for this purpose, were it not otherwise available. A relatively small amount of effort was devoted to plant and animal *communities* and even less to studies of whole *ecosystems*. Studies of ecosystem functioning, however, are central to understanding the iterrelationships of man and natural plant and animal communities. Such studies have received very little support.

Federal support for higher education related to the study of natural communities comprised a relatively small proportion of the expenditures reported.

The distribution of expenditures among topics and agencies is summarized in Table 1. About 74 percent of the total fund support was used for research and related activities. Surveys of soils, forests, range land, hydrologic conditions and animal populations accounted for an additional 23 percent. The remaining 3 percent was used for education and training. The distribution of expenditures was as follows:

Fiscal year	Intramural	Extramural grants and contracts	Higher education
1965	$106,508,000	$51,985,000	$3,929,000
1966	115,649,000	55,269,000	4,437,000

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[3] The Bureau of Public Roads which was under the Department of Commerce when agency activities were surveyed is now a part of the Department of Transportation.

TABLE 1. FEDERAL GOVERNMENT ACTIVITIES FOR THE ADVANCEMENT OF SCIENTIFIC UNDERSTANDING OF NATURAL COMMUNITIES AND THEIR INTERACTIONS WITH MAN—PROGRAM EXPENDITURES BY AGENCY IN FISCAL YEAR 1965

[In thousands of dollars]

Agency[1]	Ecological research					Surveys	education	Total
	Health, pollution, and pest control	Production of food, fiber, lumber, and industrial products	Taxonomy and other support	Soil and water conservation	Nondomesticated plants and animals			
USDA	$4,660	$11,770	$2,859	$17,143	$3,223	$28,735		$68,390
Int.	2,954	15,478	735	745	4,262	8,680	$197	33,051
HEW[2]	18,817		3,045	2,105	1,045	1,064	1,014	27,090
NSF	375	235	6,178	30	6,676	141	2,610	16,245
AEC	5,144		1,613	196	2,478	255	108	9,794
Smithsonian			4,302		362			4,664
DOD	1,188	25			572	60		1,845
NASA			1,100			90		1,190
Comm	32	121						153
Subtotal	33,170	27,629	19,832	20,219	18,618			
Total			119,468			39,025	3,929	
Grand total								162,422

[1] USDA equals Department of Agriculture; Int. equals Department of the Interior; HEW equals Department of Health, Education, and Welfare; Comm. equals Department of Commerce; NSF equals National Science Foundation; AEC equals Atomic Energy Commission; DOD equals Department of Defense; NASA equals National Aeronautics and Space Administration.

[2] Includes programs of the Federal Water Pollution Control Administration, which was transferred to the Department of the Interior on May 10, 1966.

Federally supported *research on or applicable to* natural plant and animal communities is briefly documented under five headings in this report. These efforts to increase scientific understanding of natural plant and animal communities were supported by a total of about $120,000,000 of Federal funds in FY 1965. This research was conducted or otherwise supported at many locations. It involved participation by scientists in many disciplines.

Health, Pollution and Pest Control.—Atomic Energy Commission; Department of Commerce; Department of Agriculture; Department of Defense; Department of Health, Education, and Welfare; Department of the Interior; National Science Foundation; Smithsonian Institution.

Studies of the effects of environmental factors on the natural history of diseases and their hosts and vectors are among activities under this heading. Others relate to studies of the effects of soil, water and air pollutants such as radionuclides and exotic chemicals; bionomics of pests and disease carrying organisms; and pesticidal, biological, and other means of control of pests, weeds and undesirable brush. About $32,000,000 was expended for such research in FY 1965.

Production of Foods, Fiber, Lumber and Industrial Products.—Department of Agriculture, Department of Defense, Department of Commerce, Department of the Interior, National Science Foundation.

Trees, shrubs, grasses, other ground flora, livestock, game, fish and shellfish found in natural communities are the sources of many products useful to man. Ecological aspects of research to understand and manipulate life processes, improve biological efficiency and quality of product, understand and control environment phenomona and develop more effective management and husbandry methods involved the expenditure of about $27,600,000 in FY 1965.

Taxonomy and Other Support Activities.—Atomic Energy Commission; Department of Agriculture; Department of Health, Education, and Welfare; Department of the Interior; National Aeronautics and Space Administration; National Science Foundation; Smithsonian Institution.

Biosystematic studies are conducted on animals, fish, insects, plants, and shellfish. These seek to define and catalogue species and genera and variations within and among them. In addition to identifying distinguishing morphologic characters, differences in reproduction, processes and compatibilities, life histories, physiologic responses, metabolic processes, feeding methods and geographic distribution are also recorded.

Studies of micrometeorology and remote sensing of biological and physical conditions and phenomona; the development and improvement of bioinstrumentation; and Antarctic experimentation are examples of other support activities related to advancing our understanding of natural plant and animal communities. About $19,800,000 was expended in this area in FY 1965.

Soil and Water Conservation.—Atomic Energy Commission, Department of Agriculture, Department of the Interior.

The soil and water components of natural communities are vital to plants and animals that live there. Information about ways to maintain and improve their quality and productivity are sought in field and laboratory research. Studies of soil composition, structure and texture; and water source, composition, distribution, and quantity are examples of research to better define and manage soil, water, plant, animal, and marine life relationships. These and other facets of soil and water research are a part of an overall effort to more efficiently use and more completely conserve these resources. About $20,200,000 was expended for such research in FY 1965.

Non-domesticated Plants and Animals.—Atomic Energy Commission; Department of Agriculture; Department of Defense; Department of Health, Education, and Welfare; Department of the Interior; National Science Foundation; Smithsonian Institution.

This category includes research most directly concerned with the interrelationships between plants and non-domestic animals in natural areas. Examples are studies of the interrelationships between plant communities and wildlife, animal ecology, plant ecology, and fish habitats, the effects of hurricanes on natural areas, and the causes of both short and long-term vegetational changes. Investigations of the ecological effects of water use projects on fish and wildlife and the effects of human use and beautification of wildlands are conducted to evaluate the influence of man's activities on natural communities. About $18,600,000 was expended in this area in FY 1965.

Surveys (Atomic Energy Commission; Department of Agriculture; Department of Defense; Department of Health, Education, and Welfare; Department of Interior; National Aeronautics and Space Administration; National Science Foundation; Smithsonian Institution).

This work involves identifying, measuring, classifying, and documenting existing bioenvironmental conditions; where appropriate, relating findings to preceding conditions and contributing factors; and identifying and measuring changes and trends, as well as the scope of variation and diversity.

Continuing, periodic, or one-time surveys are made. They range from national and regional efforts to activities in selected locales. Among the subjects studied were:

Biological productivity in waterways.
Exotic chemicals.
Forests.
Freshwater fish.
Land.
Marine benthonic organisms.
Marine fish.
Plant and animal pests—diseases, insects and parasites.
Poisonous or unwanted plants.
Poisonous marine animals.
Range.
Seals.
Soils.
Soil, water and air contaminants.
Whales.
Wildlife habitat.

About $39,000,000 was expanded for such work in FY 1965.

Education.—Atomic Energy Commission; Department of the Interior; Department of Health, Education, and Welfare; National Science Foundation.

Grants for higher education, including pre- and post-doctoral fellowships and traineeships; support for facilities for scientific training; the preparation and distribution of bibliographies; and scientific data centers are among activities included under this hearing. About $3,900,000 was expanded in this area in FY 1965.

III. RECOMMENDATIONS

Although considerable effort is currently being directed to understanding natural communities and their interactions with man, much of it arises from special economic problems and particularistic aspects of agency missions. The comprehensive overview of man-in-nature, which is needed for harmonious adjustment of human populations to resources, is rarely attained. The following recommendations outline steps to be taken toward achieving this adjustment.

Protected natural areas

1. *A group, composed of representatives from concerned Federal agencies and the academic community, should prepare a definitive list of natural ecosystem types.*—The Department of the Interior, the Department of Agriculture, and the National Science Foundation, should jointly assume responsibility for this undertaking. Current efforts in this direction, including those in connection with the International Biological Program, should be recognized and integrated into the system.

2. *The same group should recommend, for designation by the agency controlling the land, specific areas representing these types for protection as a natural areas.*—These areas should be adequate in number and size to use for observational and experimental research and for monitoring. Priority should be given to areas presently under public control to assure their perpetuation.

3. *If areas containing ecosystem types recommended by the group are not represented on Federal or other preserves, the group should consider how such areas might be acquired or access to them obtained through means such as lease or easement.*

4. *Designated areas should be available to any bona fide researcher, subject to sufficient regulation by the land-holding agency to protect them and prevent interference of one program with another.*

Research

1. *Greater attention should be given to studies within natural plant and animal communities.*—In this general effort, increased emphasis should be given to an ecosystem approach in which these communities are considered in the context of the total environment in which they exist.

2. *Agencies with major research programs pertaining to natural plant and animal communities should establish focal points and take other actions to facilitate interagency coordination, planning, support and conduct of programs.*—No single agency has, or should have, exclusive jurisdiction in supporting research on this subject, since research related to natural areas is an essential part of the mission, responsibilities of several agencies. Communication among agencies and within the scientific community needs to be improved to prevent undesirable duplication and to insure complete coverage. OST should assume responsibility for assuring necessary coordination.

3. *A small number, perhaps six to ten, of major intensive ecosystem studies should be conducted. As no single agency has the total capability to perform the major ecosystem studies outlined above, the agencies concerned should undertake a coordinated program including sharing of funding and support.*—The ecosystem orientation of many small-scale studies, past and present, needs to be expanded and applied to very large and complex systems, such as forests, grasslands, large lakes, estuaries and rivers with emphasis on interrelationships within and between components. The competence of both Federal and non-federal scientists should be utilized. This activity may necessitate a reorientation of some current efforts.

4. *In research on intensively managed areas where the findings may have application to natural plant and animal communities, greater attention should be given to designing experiments and interpreting results from the standpoint of their ecological implications.*

5. *Increased research should be performed to provide a basis for making the best possible judgments on the benefits and losses which accrue from the interactions of man and natural communities.*

6. *In seeking to increase ecologically oriented research commensurate with their missions, agencies should emphasize—(a) Fundamental Processes Operating and Affecting Plant and Animal Communities—*
    1. basic life and life-supporting processes.
    2. how living things relate to and affect one another.

3. how living things relate to their physical environment.

4. how the above components interact to yield an observed condition at a given time and place.

(*b*) *Impact of Plant and Animal Communities on Man.*—

1. identifying and assessing the significance of specific ways in which natural communities affect man.

2. the ways the constituents of natural communities affect man directly, or indirectly by affecting each other.

3. ways in which the beneficial effects of natural communities on man can be perpetuated and enhanced.

(*c*) *Impact of Man on Plant and Animal Communities.*—

1. identifying and assessing the effects of specific and purposeful actions of man on natural communities.

2. identifying and assessing the significance of the anticipated or inadvertent side effects of man's activities on natural communities.

3. defining more and better ways for man to use and manage the resources provided by natural communities and their environment.

7. *Steps should be taken to bolster competence in taxonomy and systematics through expanded support for professional and subprofessional personnel and for such facilities as reference collections, field stations, mobile laboratories and data processing centers.*

8. *Research on methodology and instrumentation should be continued* to:

(*a*) improve sampling and analytical methods which lend themselves to statistical interpretation.

(*b*) increase utilization of remote sensing and other new sampling techniques.

(*c*) expand the use of computers for processing data.

(*d*) increase utilization of tools for systems analysis including simulations of ecosystem structure and functions.

Surveys

Benchmark Studies

The departments and agencies responsible for specific natural areas should accept the obligation to conduct or support a limited number of localised benchmark studies in major ecosystem types. Benchmark studies on non-Federal lands or on Federal lands where studies have not been funded by the controlling agency may be funded by Federal agencies as needed to support their missions.

2. *Federal agency "ownership" alone should not preclude benchmark studies on these areas by other agencies in support of their missions.*

3. *Whenever it is economical and practical, the responsible agency should, through contracts or agreements, utilize the competence of other agencies for appropriate portions of the benchmark surveys.*—For example, the Department of Health, Education, and Welfare with capabilities in air pollution surveys, the Department of Agriculture with similar capabilities in soil analysis and the Department of the Interior with competence in water inventories should be called upon by the responsible agency to perform these functions whenever it is more practical and economical to do so.

4. *The responsible agency should also maintain a record of the location of benchmark data to serve as a point of contact and to assure ready acessibility of information to the entire scientific community.*

Monitoring

1. *A monitoring program in natural areas should be a part of broader programs for monitoring the total environment.*—The FCST Committee on Environmental Quality is presently engaged in assessing current monitoring activities and developing proposals. A survey of the needs in natural areas should be included in this review.

2. *Insofar as it is practical and economical, agencies with competence and responsibility for programs dealing with specific environmental components should monitor these components in natural areas.*—For example, the Department of Health, Education, and Welfare should have responsibility for monitoring air; the Department of Agriculture for soil; and the Department of the Interior for water. In some cases, additional legislative authority for contracting portions of this effort may be required. Such authority would be useful in situations where it is more practical and economical to utilize competence outside the responsible agency.

3. *A committee on natural areas should serve as a point of contact within the Federal establishment for information on natural areas obtained in the monitoring program.*—An informal group composed of representatives from the Department of Agriculture and the Department of Interior is currently developing reference information on natural areas.

Education

1. *Additional emphasis should be given to ecologically-oriented training.*
2. *Federal agences with missions in ecologically-oriented research should support training of students in their fields.*
3. *Ecologically-oriented national research programs, including those at national laboratories, should contribute to university education through direct involvement of students in these programs.*—The Federal Government should facilitate the participation of its scientists in research training.

Mr. DADDARIO. This committee will adjourn until tomorrow morning at 10 a.m. at the same place.

(Whereupon, at 12:25 p.m. the subcommittee adjourned, to reconvene at 10 a.m., Wednesday, March 13, 1968.)

ENVIRONMENTAL QUALITY

WEDNESDAY, MARCH 13, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:08 a.m., in room 2325, Rayburn House Office Building, the Honorable Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order.

Our environmental quality hearings continue today with representatives from independent groups which have examined specific issues in this field.

This subcommittee recognizes the value of multiple and diverse sources of information, especially when the subject is so broad as to encompass all elements of our society.

Our first witnesses represent the American Chemical Society, Dr. Lloyd Cooke, Dr. Milton Harris, and Dr. Charles C. Price. Over the past few years we have developed a useful relationship with the ACS in a number of matters. The society is concerned with environmental quality, and I am pleased they are here today.

We will hear later from Mr. Ron Linton, representing the Task Force on Environmental Health which he directed for the Secretary of Health, Education, and Welfare. Mr. Linton is with the Urban Coalition where he will be soon joined by John Gardner in their important work in human environment.

If you gentlemen then, would come forward, and proceed in whichever order you have decided. As I understand it from Mr. Carpenter, Dr. Cooke will be giving the presentation.

Dr. Cooke. Right.

Mr. Daddario. Please proceed.

(The biographies of Drs. Cooke, Harris, and Price follow:)

Dr. Lloyd M. Cooke

Food Products Division, Union Carbide Corp., 6733 W. 65th St., Chicago 38, Ill. Chemistry. La Salle, Ill. June 7, 16; m. 57. B.S., Wisconsin, 37; *Ph. D. (org. chem), McGill, 41. Phi Kappa Phi; Phi Lambda Upsilon; Sigma Xi. Mgr., Planning, Food Prods. Div., Union Carbide Corp., 1967 to date;* Mgr., Market Research, Food Prods. Div., 1965–67; Assoc. Dir. of Research, 1957–64; Mgr., Cellulose & Casing Research Dept., 1950–56. Mem. ACS since 1939. Chicago Section: Chm., 1955–56; Comm. on Pub., Prof. & Mem. Rel., 1968; Comm. on Pubs., 1968; Adv. Bd., C&EN, 1967–69; Comm. on Chem. & Public Affairs, 1965–68; CPC., 1964–67, V. Chm., 1964–67; Comm. on Patent Matters & Related Legis., 1963–67. Mem.: AIC; Trustee, Chicago Chem. Library Fund, Amer. Mktg. Assoc.; Chicago Chem. Club. Structure of lignin; starch modifications and derivatives; cellulose derivatives; viscose chemistry; carbohydrate and polymer chemistry.

Dr. Milton Harris

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Dr. Charles C. Price

B. Passaic, N.J. July 13, 13; m. 36; c. 5 Organic Chemistry, Swarthmore Coll., B.A., 1934; Harvard Univ., M.S. 1935; Ph. D., 1936; D.Sc. (Hon.) Swarthmore Col., 1950. Honor Scroll of Phila. Chap., AIC, 1961; Honor Scroll of Chicago Chap., AIC, 1955; Cert. of Appreciation from the War & Navy Depts., 1948; Dist. Serv. Award, Ind. Jaycees, 1948; ACS Award in Pure Chem. sponsored by Alpha Chi Sigma Frat., 1946. Asst. Chem. Illinois, 36–37, instr. 37–39, assoc. 39–41, asst. prof. 41–42 assoc. prof. 42–46; prof. & head dept., Notre Dame, 46–54; Blanchard prof. Pennsylvania, 54–66, dept. dir., 54–65, UNIV. PROF. 66– Vis. lectr, Polytech. Inst. Brooklyn 45. Member ACS since 1937. Univ. of Illinois Section: Chm., 1944, ACS: Pres. 1965; Bd. of Dir., ex officio, 1964–66; Comm. on Awards & Recog., 1964–66; Comm. on Educ. & Students, 1964–66; Comm. on Grants & Fellowships, 1964–65; Comm. on Chem. & Pub. Affairs, Chm., 1965–69; Comm. on Pub., Prof., & Mem. Relations, 1965–66; Comm. on Nom. & Elec., 1957–62, Chm., 1959–61; Rep., UNESCO, 1964–69; Rep. NRC–US Natl. Comm. for IUPAC, 1966–69; Ed. Bd., JOC, 1955–60; Assoc. Ed., Chem. Reviews, 1949–51. Mem.: NRC–AEC, Predoctoral Fellowship Comm., 1948–51; NRC, Adv. Subcomm. on Plastic & Rubber, 1947 to date, Div. Chem. & Chem. Tech., Member-at-Large, 1959–63; AAAS, Chm., Polymer Res. Conf. 1947, Gordon Res. Conf. on Pet. Chem. (Chm., 1950); Assoc. Ed., "J. Polymer Chem.," 1946 to date; NSF, Adv. Council on College Chem. (Chm., 1962–), Div. Comm. on Math., Phys. & Engin. Scs., 1951–55, (Chm., 1954–55); Arctic Rubber Res. Conf., (Chm., 1949) High Temp. Rubber Res. Conf. (Chm., 1953); NIH, Cancer Chemotherapy Study Section, 1959–63. Aromatic substitution; olefin reactions; vinyl polymerization; quinoline syntheses; mechanisms of organic reactions; cancer chemotherapy. Address: Dept. of Chemistry, Uni. of Pennsylvania, Phildelphia, Pa. 19104.

STATEMENT OF DR. LLOYD M. COOKE, ACCOMPANIED BY DR. MILTON HARRIS AND DR. CHARLES C. PRICE, AMERICAN CHEMICAL SOCIETY, SUBCOMMITTEE ON THE SCIENCE AND TECHNOLOGY OF ENVIRONMENTAL IMPROVEMENT

Dr. Cooke. Mr. Chairman and members of the subcommittee, my name is Lloyd M. Cooke. I am a member of the board of directors of the American Chemical Society and appear before you today in my capacity as chairman of the subcommittee on environmental improvement of the society's board committee on chemistry and public affairs.

I am also manager of planning for the food products division of the Union Carbide Corp.

Accompanying me are Dr. Milton Harris, chairman of the American Chemical Society's Board of Directors and retired vice president for research of the Gillette Co.; Dr. Charles C. Price, chairman of the American Chemical Society's Committee on Chemistry and Public Affairs and university professor of chemistry at the University of Pennsylvania; Dr. B. R. Stanerson, executive secretary of the ACS; and Dr. Stephen T. Quigley, director of the society's office of chemistry and public affairs.

Mr. DADDARIO. Dr. Cooke, the other gentlemen, who are here, should not feel inhibited in any way. They feel they have something to say. They should volunteer to do so.

Dr. COOKE. Thank you, we appreciate that opportunity. And also we appreciate very much the opportunity to discuss with your subcommittee the work of the American Chemical Society study project on the science and technology of environmental improvement.

I will begin by describing the origin of our committee on chemistry and public affairs. The basis of the committee lies in the charter of the American Chemical Society. The ACS charter was granted by your predecessors in Congress in 1937, and it says in part that one of the objectives of the society should be "by its meetings, professional contacts, reports, papers, discussions, and publications, to promote scientific interests and inquiry, thereby fostering public welfare and education, aiding the development of our country's industries, and adding to the material prosperity and happiness of our people."

The society, as you may know, has been doing things of this sort for many years through local, regional, and national meetings, publications, and other activities. However, with the steady growth of the American Chemical Society—we now have about 110,000 member chemists and chemical engineers—the society's responsibilities have increased.

In a technological world in which chemistry plays an exceedingly important part, the role which the society must play has been reevaluated. Thus in 1965 the ACS Board of Directors decided to form a new operating entity, the committee on chemistry and public affairs.

In support of the committee's main responsibility to help fulfill the obligations imposed on the society by the national charter, the committee was charged with the responsibility: "to initiate and conduct studies and prepare and publicize to the membership and the public reports on problems involving the role of chemistry in public affairs."

Now, having provided some background on the why and the when of the ACS Committee on Chemistry and Public Affairs, I will bypass the events which lead up to the purpose of our visit here today. Later, I will speak to some aspects of this bypassed experience. However, one of the first actions of the new Committee on Chemistry and Public Affairs was to respond to the so-called Tukey report "Restoring the Quality of Our Environment." Our response has been to question and to experiment in order to determine the need for ACS action, and after validating the need, determine the direction and the mechanism for a society effort in this critical problem area. This mechanism is perhaps best introduced by permitting it to speak for itself. I will read to you from the preface of the society's report on "The Science and Technology of Environmental Improvement" which report is now in preparation.

Our aim in this report has been to set down in one place an objective account of the bearing of chemical science and technology on the problems of environmental quality—what is known, how it is being used, what needs to be known, how it might be used.

We have not attempted to write an all-encompassing textbook or primer. We have stressed instead those problems that we believe to be at the same time important to environmental quality and accessible to
We have not dwelt overlong on the dimensions of the pollution prob-
attack on the basis of current and prospective chemical knowledge.
lem, except where one or more of those dimensions is specifically germane to the point at hand, nor on the social, political, economic, or organizational questions that it raises. Others have covered these matters at length. Our intent rather has been to focus strongly and specifically on chemistry, chemical engineering, and the related sciences, and thereby, to stimulate the chemical awareness and the flow of chemical know-how that are essential to any long-term rational approach to understanding and managing our environment.

For officials at all levels and in all branches of government who must deal with the environment, we hope to have developed a coherent chemical picture that will refresh the expert and inform the nonexpert.

For the chemical world at large, we hope to have exposed the important chemical aspects of pollution and, by extensive documentation, to have made it possible for the working scientist or engineer to proceed without delay to the scientific or technological background of whichever of these questions happen to excite his interest or become his assignment.

Mr. Daddario. Dr. Cooke, when do you expect that this report will be released? To what type of audience will it be specifically directed?

Dr. Cooke. If all goes uncommonly well, by early fall. Midwinter might be more likely.

Mr. Daddario. Aimed at whom?

Dr. Cooke. As stated in the preface, the report is aimed at agencies who have assignments in the area of environmental control as they might relate to chemistry, and also to scientists (1) to excite their interests, and (2) to help provide background information so that they may start research projects more expeditiously.

Mr. Daddario. These are most commendable objectives. The aim to involve people with the role of chemistry in public affairs is extremely important.

The question I have, and one that bothers me somewhat. You have with you a tremendous competence. You are manager of planning for the food products division of Union Carbide. Dr. Harris has been vice president for research of Gillette. Dr. Price has had tremendous experience in public affairs. He has worked with this committee on many occasions in the past.

Why is it that any involvement in the social, political, and economic areas is avoided, especially the organizational questions. These are, in my opinion, real difficult roles.

How do you view the way agencies in government are established to handle this problem? What are the problems of management? How do industry, the universities, and government play their part? What do you think of the laws pertaining to clean air and water? The way Congress is structured to handle these problems.

Don't these subjects deserve some attention? Aren't you gentlemen of the society the type of people who have been involved in the management of affairs of this kind?

Dr. **Cooke.** May I start to try to answer that question? And I would hope, after a brief statement, that Doctors Harris and Price will speak, too.

The segregation, shall we say, of objectives, and apparent negative statement with regard to organization, social and economic factors, was by no means meant to denegate their importance, nor the capacity of individual members of the society, to speak constructively to those factors.

As we view the situation thus far, we feel that the solution of economic and organizational problems require (1) the definite, positive statements of the problem, (2) a compilation of what knowledge there is to work with, (3) and what needs knowing in some relationship to importance (establish priorities). This is not to suggest that others do nothing now, while waiting until such are available, but rather for us to concentrate our skills, expertise, and participation of knowledgeable chemists in industry, government, and universities to help provide a basic story of what we know, and what we need to know.

After accomplishing this, I am certain that many of us will then recommend ways to organize to achieve the ultimate aims. However, we feel it is imperative that our first priority job be to pull together, as well as we can, in one place, the chemistry and chemical engineering related to these problems. Define them, and define the need. By no means do we mean to delimit or denegate the importance of the social and political aspects. But, in order of priority, we have chosen the technical approach, we think, intelligently.

Mr. **Daddario.** Well, it is not in the nature of my question to be critical. I would quite agree that we ought not to wait until we can prove out what we need to do, before we get about doing it. But I would hazard the guess that as you gentlemen review what is being done, you could come to these conclusions: some of it is being badly managed. Some things are being done we ought not to be doing, and some things are not being done which we have a great competence to do and ought to be done. This fits into the pattern of organizational, political, economic, and social questions, if we are doing things which are economically unsound and if you had some suggestion as to what needed to be done in order to develop a greater competence in programs presently in existence. How might these be replaced to accomplish certain end objectives which would give us leadtime for learning more about things that ought to be done? Not just chemistry is involved here, but the management part of this is extremely important.

Dr. **Cooke.** Then, sir, I think, appraised this way, that we are expecting and hope to come up with many such specific recommendations and commentaries with regard to the relative economics of certain processes. Further in my testimony I will make specific reference to one or two such cases as examples of what we hope to achieve.

Perhaps we have overemphasized the fact that we are approaching the problem from the scientific knowledge basis, rather than from the standpoint of economics and organization. This is not meant to deny the importance of scientific knowledge in recommending courses of political and economic action and possible mechanisms by which action might be taken.

Mr. **Daddario.** While we are on the subject, does Dr. Harris, Dr. Price or any other gentleman want to say something about this?

Dr. **Harris.** I don't have to tell anyone in this room that this is one of the important problems in our society. It is also a problem loaded with emotion. The spectrum includes those who feel that there is no problem to those who feel that the minute we put our heads outside, we are not going to live more than 2 or 3 years.

In order to develop a meaningful way to tackle a problem as complex as this, we felt that we ought to know more about the technical aspects of the problem. One should not develop an advertising or sales campaign for a product that doesn't exist. It is really not a very easy thing to do. Rather, we should find the meaningful technical aspects of the problem, especially in our areas of expertise. Here we have an advantage, since the ACS comprises 110,000 members including leaders in the academic, industrial, and government communities.

Many among this group feel that this is one of our important social problems. However, they really don't know what to do about it nor their fields of expertise can contribute to solutions. Thus, if we can come up with much more meaningful technical definitions in our areas of expertise, I feel we can contribute much.

Mr. **Daddario**. Dr. Harris, we would rather not, too. But I think this is a time when, recognizing the reasons why this is being avoided in this case, there are high emotions. There are people who are at each end of the spectrum. In my opinion, we don't have the time to work this out over a long period of time. We need an answer, not necessarily an ultimate solution in each instance, but we need to develop some way to get hold of these great problems earlier, rather than later. Somehow these conflicts within your society have to be reconciled—not reconciled so that you have a unanimous approach to things, but it would seem to me it would be even better if your society were to participate in giving us advice with minority points of view, if necessary, so that at least the nature of the conflict could be understood. I am not being critical because I recognize the problems of the society. At the same time there ought to be developed a mechanism of getting these opinions in public where they could then be refined somewhat. People do have a tendency, when they have taken a position, and have been criticized, to perhaps adjust themselves somewhat.

Dr. Price.

Dr. **Price**. I find this discussion extremely helpful, and in fact it is one of the reasons we wanted to come today when our report was still in an incomplete stage so that we could find out the ways we could be most useful. I am sure that if we can see ways we can make recommendations in this area we will be willing to do so.

I think there were several reasons for reluctance to aim at that direction, one of which is we are only one aspect of the problem. The chemists have a competence to deal with only one aspect of the problem. The chemists have a competence to deal with only one facet. For example, the biological problems, ecology, are extremely important parts of evaluating the social and economic aspects. We didn't want to presume to undertake this from only the limited base of chemistry. But I do believe that we ought to try to find ways to make recommendations, and I think when they are clear, we will. But I think it would have been a mistake for us to presume to speak from just the basis of chemistry to make a broad recommendation in these very important areas.

Dr. **Harris**. Early in this undertaking, we met with Don Horning and his staff. We wanted to make a contribution in this area but did not want to be in the position of the society which forms a committee and then says "We would like to be helpful, give us something to do." What we proposed was to really find out what the technical aspects of the problem were and then make suggestions. There are too many "do-gooders." We recognized the need for more meaningful approaches and I think we hope to near that stage very quickly.

Mr. **Daddario.** I recognize that this is one of the problems and that what you say is so. In this instance, you have come forward to be helpful, and it becomes a matter of coming to some determination of a formula.

I don't know, Dr. Price, whether I can go along with you when you say because you are in the chemical end that you have no view of how the other parts of this little world live. I am sure Dr. Cooke and Dr. Harris, in their day-to-day work, have had to come to determinations about how to manage other things beyond chemistry. The ability that you people have to look at these things from the eyes of managers transcends by far your expertise in the chemical area, where your fundamental capabilities lie.

You really have a better capability and that is the reason we asked for advice in this area from people precisely of your kind. It is not a narrow view you can give, but a wider one. You may be right in what you have done for some of the reasons you have all given. On the other hand, it would appear to me at first blush that it is a narrower point of view that you give us than the broader one that you are in fact capable of giving us.

Dr. **Harris.** We are prepared to help in every way possible. But as I said before, I hope that when we come forth with recommendations and suggestions, which I am sure we will be able to do, based on our capabilities, they will be something more than just idle suggestions.

Mr. **Daddario.** Were you going to say something, Dr. Cooke?

Dr. **Cooke.** I would perhaps state my viewpoint somewhat differently.

I think our field of chemistry provides an excellent base from which to build knowledge and understanding which, in turn, would permit a better opportunity to impinge concepts of management and control and organization. It is, I think, his conviction too that——

Mr. **Daddario.** When you say "his," you mean Dr. Price?

Dr. **Cooke.** Yes, I mean Dr. Price—that, of the disciplines which may be directly involved in the technical aspects of the problem, perhaps chemistry is most pervasive, most general. Of the possible organizations which could start from some solid basis and expand, as you suggest, we feel that the ACS, by representing a unique cross section of industrial, academic, and agency people, is particularly well suited for this purpose. Thus, for example, at a meeting called by a division of the ACS 2 years ago, a group of experts in environmental science proposed to provide public service by broadening the scope of national meeting seminars to include scientists from other disciplines—biologists, mathematicians, sanitary engineers, etc. This has been done for 2 years. During this time we have succeeded in bringing in many people from other disciplines. Thus, although we appear to be starting from a limited base in chemistry, in fact, we find that we are able to bring in other scientific knowledge effectively.

So I would suggest that we proceed further into a discussion of what we propose to do and bring in a couple of examples. I think you may find that we will cover some of the points which you have raised. Perhaps we have not planned to go as far as you would encourage us to go, but perhaps when we examine those examples, we might be able to speak more specifically to your suggestions.

Mr. DADDARIO. Yes. We ought to get along. I am pleased, of course, that these other points will be raised, but it seems to me that the report you are putting out ought to be discussed.

Dr. COOKE. This we intend to do.

The content of this quoted preface delineates the boundary conditions of our study.

The society is convinced that there is a real need for this kind of report and we believe that we are in a favored position to do the job within the limits of our resources.

Let me establish the qualifications of the American Chemical Society to do an analysis of this kind. The 900 members of the ACS Division of Water, Air, and Waste Chemistry include many of the people trained in chemistry and closely related sciences who are working on the problems of environmental quality in the United States. Many other society members are knowledgeable in the problems that need to be solved.

We have taken advantage of this expertise in our effort to develop a dispassionate and specific analysis of the chemical problems involved in managing our environment and how they have been—the problems—have been or might be solved.

The first draft, representing only a part of the planned content, will be the subject of critical review this afternoon and evening in New York City by our subcommittee consisting of Dr. William O. Baker, vice president for research, Bell Telephone Laboratories; Dr. Arthur M. Bueche, vice president, General Electric Co.; and Dr. Frank A. Long, vice president for research and advanced studies, Cornell University.

Also present for the review will be Dr. Melvin Josephs, managing editor of the American Chemical Society Journal, Environmental Science and Technology, and Dr. Stephen T. Quigley, director of the American Chemical Society's office of chemistry and public affairs.

Dr. Thurston Larson, head of the chemistry section, Illinois State Water Survey, who leads the American Chemical Society task force of scientists who are actively engaged in research in water, air, and waste chemistry, will also participate.

Since our effort began, two major documents on the environment have been published. One is "Waste Management and Control," the so-called Spilhaus report, published in March 1966 by the Committee on Pollution of the National Academy of Sciences—National Research Council. The other is "A Strategy for a Livable Environment," which was prepared for the Secretary of Health, Education, and Welfare by his task force on environmental health and related problems and published in June 1967.

I will use one or two points from the Tukey and Spilhaus reports to illustrate the kind of thing we hope to be able to do in the completed ACS report.

The Tukey report, for example, mentions at a number of points the importance to antiknock rating of the lead that reaches the atmosphere through the use of lead alkilis in automotive gasoline. We think that we can add some chemical perspective to a discussion of lead. We would do this by putting in one place all of the relationships among the chemical phenomena involved: The effect of lead on the development of currently known catalytic converters to burn the hydrocarbons and carbon monoxide in exhaust gas; the effect of lead on currently known catalytic converters designed to eliminate oxides of nitrogen from exhaust gas; the chemical nature of gasoline and the consequences, both technical and economic, of removing the lead from gasoline; the effects on the prices of certain petrochemical based plastics at the consumer level if lead were removed from gasoline and the antiknock rating maintained by chemically altering the molecular structures in the fuel.

We can also raise and suggest answers to other pertinent questions: What are the real chances of cleaning up automobile exhaust without using catalysis? Is it thermodynamically possible to remove oxides of nitrogen from exhaust gas without using a catalytic approach? What is the mechanism by which lead poisons catalysts?

Once we understand the mechanism, will it be possible to design catalysts that function in the presence of lead?

What kind of research would be required to find out if lead actually does interfere with the operation of certain enzyme systems in the body, thus producing subclinical effects of an unknown nature?

In short, the technical question of lead is a controversial one and we hope that by using our committee approach we can set down an objective appraisal of the situation in specific chemical terms.

The Spilhaus report comments that "More technology is needed in the areas of low-cost source control devices, especially for sulfur dioxide."

To a discussion of that kind we would add specific descriptions of the major processes now available for removing sulfur from stack gases at the concentrations in which it is found there. We would point out the apparent costs of such processes. We would point out that no process of that kind is yet operating on the scale required at a modern powerplant, although two or three are in the process of being installed.

We would point out that, for some of the reactions involved in these processes, what actually happens, chemically, is not entirely clear, and we would ask whether knowing what actually happens would have any substantial effect on the efficiency and cost of operation of the process.

We would assess the technical likelihood of being able to remove sulfur from oil at substantially less than the present cost. We would point out that particulates created by burning low-sulfur coal are more difficult to collect in any electrostatic precipitator than are particulates from a coal that contains more sulfur.

In New York City this means that Consolidated Edison's precipitators go from 99 percent efficiency to 98 percent when the company switches from coal at 2 percent sulfur to coal at 1 percent sulfur. The 99 percent efficiency level will be required by law for all coal-burning equipment by next year, coal of not more than 1 percent sulfur content will be required by law by 1971.

Consolidated Edison can counteract the effect on its precipitators in several ways, although at somewhat greater cost. There are numerous instances of effects of this kind—effects that are based on the scientific facts of the case at hand—that rarely are spelled out in more general discussions of what degree of pollution abatement can be achieved in specific cases and at what cost.

Sometimes the effect is important, sometimes it isn't. But at any rate, we believe that we will be performing a service by exposing this kind of technical detail in the context of the more general discussion.

Mr. DADDARIO. Dr. Cooke, is there any relevance to the lead health problem? You do not mention it here.

How does it fit in?

Dr. COOKE. I refer, as an example, to the phrase:

> **What kind of research would be required to find out if lead actually does interfere with the operation of certain enzymes systems in the body, thus producing subclinical effects of an unknown nature.**

We would emphasize those areas in which there is known data with regard to effects of lead, and those in which there are not. In the latter case we would indicate which data might be collected and provide suggestions as to how.

Mr. DADDARIO. I see. Then you have not——

Dr. COOKE. We have not ignored that possibility. We have not crossed it off. This sentence was meant to fit within the narrow confines of this morning's testimony. It was meant to point out the need for additional information. In the second example, concerning sulfur in coal and precipitator efficiencies, we point out the purposefulness of bringing technological data alongside economic data to help provide more realistic forecasts of the technological and economic merits of course A versus course B.

As I said earlier, it is with these examples that we hope to point out how we will use technical knowledge to point out the areas where economic and health problems pertain. Also, to the extent we can, we will relate the technological facts to the economic and the health problems.

Studies of environmental quality generally conclude that analytical chemistry is vital to developing new knowledge of the processes involved.

Our study would illustrate the problems and achievements in specific terms. We would point out, for example, that until the past year or so, there has been no means of making standard samples of many air pollutants, at the concentrations at which they actually occur, that could be used to calibrate the methods and instruments that we use to measure such pollutants.

There are things that can be done to make progress in the face of such problems, but they are problems nevertheless that must be solved sooner or later and the existence of such problems means that we must always be certain what kind of information we are dealing with.

For example, the national air surveillance network in the past couple of years has improved its analytical techniques for nitrogen dioxide. One result is that the nationwide readings for 1966 are recorded at values of 50 percent higher than they were in previous years for the same actual concentration of nitrogen dioxide in the air.

This, then, is the kind of perspective that we hope that we, as a scientific society, will be able to provide.

In retrospect, let me now describe briefly some of the problems that a society such as ours encounters in organizing for such a venture. In fact, we still have to validate the efficacy of our present approach. The value of our testimony may lie in submitting some of our probing experiments for your review.

As I stated earlier, the formation of the Committee on Chemistry and Public Affairs coincided with the publication of the President's Science Advisory Committee document commonly called the Tukey report. The first reaction of the committee to possibilities of constructive participation in areas of pollution control was that PSAC and other bodies were charting reasonable courses which appropriate agencies could follow directly or amend with experience.

Subsequently, the committee realized that the membership of the American Chemical Society might provide a unique cross sectional representation of experts in the field of environmental quality. If this were true, perhaps a group of such experts, as represented by membership in the Division of Water, Air, and Waste Chemistry, and the American Chemical Society's Board Committee on Air Pollution, might welcome an opportunity to explore areas wherein the society might serve chemistry and the Nation purposefully.

That expert members of the society were interested and willing to participate in such an exploration was quickly affirmed, and from a meeting of such members in March 1966 came the following recommendations:

1. Members of the American Chemical Society experienced in environmental chemistry and technology could provide a valuable service by analyzing the recommendations of the Tukey report, as related to chemistry.
2. The American Chemical Society should determine those areas where basic chemical knowledge related to environmental control is lacking and encourage and/or sponsor appropriate research.
3. All chemists must be informed of the scientific problems encountered in environmental control.
4. The ACS Division of Water, Air and Waste Chemistry should arrange broad spectrum symposia on environmental control, and, by broad spectrum, we meant their bringing in other related disciplines, the sanitary engineers, the biologists.
5. A scientific journal concerned with the chemistry of water, air and waste materials should be established. In January 1967 the ACS began publication of Environmental Science and Technology, a professional journal that now has a circulation of more than 12,000. This journal covers the news of environmental science—not just chemistry—and also serves as the American Chemical Society's publishing outlet for reports of original scientific research in the field.
6. There is need for a documentation center for toxicological information. A similar recommendation was made by PSAC and these recommendations were implemented by the establishment of a toxicological information center in the Department of Health, Education, and Welfare.

The American Chemical Society decided to help implement most of these recommendations with special emphasis on underwriting an analysis of the recommendations of the Tukey report from the standpoint of chemistry. At that time, as Dr. Harris has indicated, these plans were described to Dr. Donald F. Hornig, Director of the Office of Science and Technology, for purposes of communication and to obtain whatever counsel and suggestions his office might provide.

Dr. Hornig encouraged the American Chemical Society to pursue the proposed program, placing special emphasis on items 1 and 3 above: that is, preparing an analysis of the recommendations of the Tukey report and informing the scientific community of problems faced in improving our environment.

Recruiting of scientists to participate in our task force proceeded smoothly because all were convinced that the program provided a valid opportunity to fill a real need.

The high level of enthusiasm and dedication continued throughout all stages of planning, group study, decisions with regard to assignment of people and topics, and finally providing well-written segments of what was then planned to be the ACS report.

However, at this stage it became apparent that the documents provided had, on the one hand, somewhat exceeded the original limits of the analysis of the recommendations of the Tukey report. On the other hand, that which was provided was not extensive enough to show "what is known and what is needed" to solve environmental problems.

Your subcommittee experienced a somewhat similar situation at about the same time. You were faced with bringing intelligent order out of the wide variety of information contained in the massive 2-volume collection of your hearings in 1966 on environmental pollution. We were much impressed by the monumental task performed by the team headed by Mr. Richard Carpenter of the Library of Congress. We took heart from your success.

We do not believe that science and technology make up a panacea for environmental improvement and control. We do believe that the technical facts should be made fully available in an unprejudiced fashion to those who must make the decisions. We are not yet certain that we have found the best way to do this, which is to say that we regard our current effort as experimental. But without experiment we will learn nothing and the one thing that we are convinced of is that we must search out the proper role of a modern scientific and educational society in the context of public affairs. Until we know what that role is, we may be wasting a valuable resource.

We think we are now on the way to meet part of a criticism your report leveled at the scientific community. Your subcommittee has said:

> Finally, the hearings indicated that environment quality, with its deep roots in the natural sciences, has not yet attracted sufficient attention from the scientific and engineering community. This is a problem worthy of the very best thinking we can muster.
>
> It should receive a more generous allocation of the scientific resources at our disposal.
>
> Corrective activities involve long-term commitments and high costs which provide clear motivation for additional research, development, and demonstration projects. Technology is available to accomplish some urgent objectives and should be used without delay.
>
> In many other instances, the knowledge is lacking to define objectives and to deal with pollution on a cost-effective basis.

It is our aim to help answer this call.

Thank you.

Mr. Daddario. Dr. Cooke, I am pleased that you made note of Mr. Carpenter's tremendous contribution to the work of this subcommittee, and to all, actually, in this field.

I think it is a tribute not only to him but to the fact that the chairman of the full committee, Mr. George P. Miller, has given support to the establishment of a scientific and technical competence in the Library of Congress, which over the years has been of tremendous assistance to us. The recognition you give to Mr. Carpenter, and he is deserving personally of it, is an indication of the scientific and technical community's recognition of this competence which the Congress leans heavily on.

This is an important development in the building up of confidence generally as to our ability to handle these matters.

You mentioned your report which you plan to release in midwinter of 1968.

I wonder what concern might have been shown from time to time as to problems such as this? For example, HEW is already setting criteria and certain States are being required to establish standards for ambient air.

Does it concern you? Should these standards be established? What problems arise by the HEW forcing on certain States, which really do not have the competence to establish such standards?

Once these are fixed, the problems of readjustment always come up.

Since you have said you have so many bits and pieces of this report to put together, if certain parts of it are critical at this moment perhaps it could be released earlier. It might stem off some of these problems which might otherwise arise.

Dr. COOKE. We are well aware of the fact that there is a nutcracker effect here. As you said earlier, we must act as well as we can within the framework of the limited knowledge—too limited knowledge—which is there to be brought forth in a document such as ours.

We have faced up to the fact that actions, recommendations and directions will go on (even before the facts are available). This is true of the example I gave earlier with regard to sulfur dioxide and precipitator defects when one uses lower sulfur fuels. These kinds of things are happening daily. Had we been faster, doubtless we could have been of more help.

We are unhappy with the delay that has occurred, that we didn't seem to get on the present track as soon as we liked. We have learned much from this experience, and hope it will be helpful to others.

We have not ignored the problem of the need for action before all the facts are in. We are aware of the report from Health, Education, and Welfare and the recommendations therein. As a result of your questioning we will perhaps look more acutely at data as it unfolds while preparing the report. We will attempt to judge our timing in terms of other events.

May I then conclude by stating that your point is valid. I mean that in the sense that we recognize it. We are caught in a balancing act while attempting to get the whole thing done rapidly. We will definitely bear in mind your expression of the need to provide data or information early as it may be uncovered. We are not just waiting until we have a neatly bound volume. Rather, we are waiting until the individual sections are validated and tested as well as we can—not forever, but tested well enough to be meaningful and purposeful.

Mr. DADDARIO. I certainly would not want to push you into doing something earlier because precipitous actions and recommendations could, if wrongly placed, do great harm to what follows. We also set our goals for certain times and then find ourselves putting reports out later on. But we have on occasion found that we had to, in fact, put out a report earlier, rather than later.

Dr. **Cooke.** We have considered that point very seriously with regard to the pesticide portion of the original submission. We decided, in terms of the depth and reliability of the information then available versus the apparent lack of immediate pressure and need in that area, that we would be more serving, better serving, by waiting until other sections were completed.

The point is, we actually seriously considered publishing a part of the report before completing all of the report.

Mr. **Daddario.** But the fact still remains, while you gentlemen who have such competence in this area have great concern about certain of these problems, standards are in fact being set.

Dr. **Cooke.** We get the message. I agree.

Mr. **Daddario.** Now, your work, in the preparation of this report, involved people from universities, industry, and the agencies. Has the opportunity come up within that framework to come to some judgment about inadequacy of information available to you or what the government agencies find inhibiting them from doing an efficient job?

Has this been part of the discussions?

This gets back again to the management question which I raised earlier.

Dr. **Cooke.** Yes, it will be part of the report.

Mr. **Daddario.** And will be part?

Mr. **Cooke.** Yes.

Mr. **Daddario.** Dr. Harris, do you have any comment on the point I raised with reference to standards being set at this time, when you gentlemen are still wrestling with what ought to be done?

Dr. **Harris.** We are always aware of the need for standards but are concerned about standards based on poor data. It is always easier to put in standards than to get them revised later.

I, for one, have taken very much to heart your suggestions, and will see what we can do by way of testing any of our knowledge in order to speed up developments.

Mr. **Daddario.** One point that seems to follow here: Do you have any suggestion about what States ought to be doing that are under the gun with certain time limits? If they do not establish the standards, conflicts then arise as to what ought to be done. Taking into consideration the problems we have in establishing the criteria, should it, in fact, be held in abeyance or would it be better to go ahead with the information we presently have on hand and then wrestle with the problem of readjusting standards at a later time?

Dr. **Harris.** That is a very broad order. We are in the position of making the decision as to whether you freeze a model and build a DC–3, or do you wait until you are ready to build a jetplane.

Technically you are better off building the DC–3, gaining experience, continuing R. & D., go on to the DC–4, and eventually to the jetplane or SST.

Mr. **Daddario.** I don't know whether I go along with the analogy.

Dr. **Harris.** But the DC–3 was valid.

Mr. Daddario. The criteria that went into the DC–3 was known. We knew what it would do.

Do we know what is going into this criteria and will it, in fact, fly?

Dr. Harris. Well, my answer to that, as stated in my original statement is the need for more valid information, not only in terms of technology but also in terms of economics and social relationships. For example, one would not want to put industries out of business and destroy our economy. These are all interrelated in a very complicated way.

But most of all, I think what we need is meaningful technical information on which to base standards.

Mr. Daddario. I would agree with you.

I am not placing obstacles in the path of getting these things done because it seems to me we ought to get people thinking about them. If they aren't prepared, they will begin establishing governmental agencies as they develop a competence of one kind or another.

I feel because this is a problem we ought to get your advice about it.

For example, in New York City, Commissioner Heller has already begun to back off from the 3 percent sulfur in coal for 1969 and 1970.

Once you say to an industry, this is what we expect, they begin preparing plans, and in some case even construction, to meet those requirements. You run into a tremendous economic disruption. This can be extremely harmful to the financial structure of a whole industry.

Dr. Cooke. Mr. Chairman, may I speak rather bluntly to the point you are raising, to tell you what travail we have experienced in attempting to pick a course between these two points.

To provide a purely scientific document may take 3, 4, or 5 years, to issue as firmed up a possible, versus replying or responding to situations that might arise before the report issues.

Let us go back to the meeting with Dr. Hornig and an admonition from him that is quite pertinent. Dr. Hornig said that, one of the worst things that could happen would be for this report to appear to issue from chemical industry.

Now you just mentioned the problem with regard to 3 percent sulfur. We have felt under a gun here. If our first reply, or statement in the area of environmental quality, is negative, that is, critical of an agency recommendation, we would really pull the rug from under the effectiveness of our future contributions, unless we really have an overwhelming mass of data to support our criticism.

This is not to say we are not aware of the problem and the potential, but we feel strongly that what we finally provide you, the agencies, and the scientific community, must be of a caliber immediately recognizable as of high caliber and usefulness, and that it has no taint of vested interest. This report must represent a scientific response to the problem so clearly and so credibly that we can then be of maximum use to you and to other agencies as new situations arise in the future. After that has occurred we may then be able to make recommendations earlier, with less data, and with indications of data still to come.

This has been the major constraint, you might say, under which we felt we must operate. I think we are saying that, we may have tied ourselves down too much. But that is a tricky question to answer, too.

Mr. **Daddario.** Your explanation is certainly valid. You have a dilemma. You may have worked out a wise solution to it. But nonetheless, there are problems.

Dr. **Cooke.** There are many problems there.

Dr. **Harris.** Correct.

Mr. **Daddario.** Dr. Price, you seem to have something to say.

Dr. **Price.** I am just agreeing with that. The problem that we have had to face, and as chairman of this committee, I felt particularly this way, that since this will perhaps be the first major report that we will issue, it is especially important to establish the value and credibility of our efforts to have it carefully documented. We may have been a little too conservative.

I think maybe you understand, since this will be perhaps the first major effort this new committee has made, we have taken a fairly conservative position.

Mr. **Daddario.** Despite questions I raised, I am extremely heartened by what has been done. I raised the questions, because it is my responsibility to come to some kind of an understanding about this.

Do any of you, or your colleagues, have any further remarks?

Dr. **Price.** In closing, all I would like to say is that we appreciate the opportunity that this gives us to be made aware of the major needs that you people are facing up with, and I hope it will also help inspire us to make sure that we do all we can. We need inspiration to see what we can do to help solve these problems. I think these hearings are a little bit of a needle for us to make sure we accept our responsibilities in this area.

We appreciate the needle.

Mr. **Daddario.** The meetings weren't put together for that purpose, however.

Dr. **Price.** But that is a purpose they will serve.

Dr. **Cooke.** We understand you.

Dr. **Price.** We made notes of many of the important questions.

Mr. **Daddario.** We certainly appreciate your coming and your cooperation.

Thank you.

Dr. **Price.** Thank you very much.

Dr. **Cooke.** Thank you.

Mr. **Daddario.** Our next witness is Mr. Ron M. Linton. Would you please come forward?

He is with the Task Force on Environmental Health and Related Problems, of HEW.

We are pleased to have you here, Mr. Linton.

Mr. **Linton.** It is a pleasure to be with you.

I prepared a statement which I submit to you for the record, Mr. Chairman. At your pleasure, I could either read it or proceed to discuss it.

Mr. **Daddario.** Why don't you use your own judgment and handle it any way you like?

Mr. **Linton.** All right.

(The biography of Ron M. Linton follows:)

Ron M. Linton

Ron M. Linton, a native of Detroit, Michigan, is National Coordinator of the Urban Coalition, a post he assumed last fall when the organization was formed. He had been director of special projects for Urban America Inc., but went on leave to serve the Coalition. Linton became assoicated with Urban America in November, 1966, at almost exactly the same time that the Secretary of Health, Education and Welfare appointed him Chairman of a Task Force on Environmental Health and Related Problems which completed its task in June, 1967.

Before joining Urban America, Mr. Linton was for more than three years chief Clerk and Staff Director of the U.S. Senate Committee on Public Works. In that post he had major responsibility for the development and enactment of Federal legislation in a broad range of fields, including air and water pollution control, solid waste disposal, highway construction and mass transit programs, civil works projects, Appalachian development, and regional economic development programs.

Linton's experience in Washington began in November 1959 as a Congressional Fellow of the American Political Science Association.

This assignment in Washington interrupted a journalism career which began while Linton was a student at Michigan State University. Majoring in political science, Linton was editor of the newspaper at Michigan State until a year before his graduation in 1951, when he joined the United Press. After service as an officer with the First Armored Division during the Korean War, Linton re-joined United Press International, working first in Des Moines, Iowa and later in Grand Rapids, Michigan, and finally in Lansing, Michigan. In 1954 he was Press Secretary to the late U.S. Senator Blair Moody.

After Moody's death, Linton served as Assistant Press Secretary to then Governor of Michigan, G. Menner Williams. He was assigned by the Governor to work with the Michigan State Department of Economic Development and was later appointed Secretary of the Department of Workman's Compensation with responsibility as the chief administrative officer of that Department.

In 1956, Linton joined the Louisville COURIER-JOURNAL, where he was Labor Editor until his assignment to Washington under the American Political Science Association Congressional Fellowship Program.

From March through November 1960, Linton was a member of the personal campaign staff of then Senator John F. Kennedy.

After the election of 1960, the late Senator Pat. McNamara of Michigan, who was Chairman of the Senate Special Committee on Aging, asked Linton to join the Committee staff. In that assignment Linton produced the first national survey of the implementation of the Kerr-Mills Act to provide medical care for the aged through Federal grants to States.

In May 1961, President Kennedy sent Linton on a special assignment to the Defense Department to head a task force project to develop a program to relate Defense spending to the Nation's economic needs. In the course of his work at the Defense Department, where he was ultimately named Director of Economic Utilization Policy, Linton devised policies and a program which improved the techniques of relating unused skilled labor and production facilities to defense needs.

It was at the conclusion of his work at the Department of Defense in 1963 that Senator McNamara called on Linton to return to Capitol Hill in a key Committee assignment.

As Chairman of Secretary Gardner's Task Force on Environmental Health and Related Problems, Linton headed a six-member group of persons from outside the Federal government whom the Secretary has asked to recommend Departmental goals in the area of environmental quality and health protection.

Linton was born May 7, 1929. He is married to the former Nancy Cox Gualt and has two children. He has strong interests in conservation, and is a member of the Shenandoah Natural History Association. He is also a prominent layman in the Unitarian Universalist Denomination.

STATEMENT OF RON M. LINTON, ENVIRONMENTAL MANAGEMENT CONSULTANT

Mr. **Linton.** When I used to sit on the other side of the dais, it always meant a long statement, if they didn't read it, and a shorter one, if they did. So I think in the interest of time, I will just proceed to read my statement and then offer myself to questioning from you and Mr. Miller.

A little over a year ago, former Secretary John Gardner, concerned with the extent to which the Department of Health, Education, and Welfare was meeting its responsibilities in providing Americans with environmental protection, created a six-member task force on environmental health.

I had the good fortune of being designated by the Secretary to chair that task force.

The six members represented a variety of disciplines. Our charge was to recommend to the Secretary the goals, priorities and strategy to cope with environmental threats to man's health and welfare.

From beginning to end of our work, the single, most constant theme we heard and understood was the urgency for action. We are in an emergency to prevent the destruction of our physical environment, yet we are not even appropriating authorized dollars.

We undertook our assignment from the view of how the Secretary could best direct the Department's resources so as to most effectively discharge its responsibility as assigned by congressional legislation.

Thus our work was essentially to recommend what needed to be done so that the Secretary could make the necessary decisions.

We attempted to make recommendations which could be implemented within the authority of existing statute. I believe about half of our recommendations would require no additional congressional authorization, albeit it would require some additional appropriation.

The remaining 50 percent, requiring congressional authority, are to a great degree responsive to implied congressional desire but lacking specific statute.

Only the metals and consumer protection goals represented a substantially new area of legislative activity. Subsequently, of course, consumer protection has come in for considerable interest by the Congress.

The task force decided initially that it would not spend its time reproving that environmental problems existed or even testing the validity of the tehcnical aspects of the problems. We felt there had been many experts preceding us who had made reports on the nature of the problem, and who evaluated much of the technical aspects related to the problem. We viewed our charge as recommending what should or could be done on the assumption that the problem was real and existing technical solutions valid.

What can be done takes two forms—today or now, and tomorrow or in the future. There is much less difference between these two time elements than most people realize. What we do now will determine what we have to do in the future. Our concern was to recommend action to be taken now that would bear upon Government's ability to deal with the future.

We also proceeded from the standpoint of what the Department of Health, Education, and Welfare should do in relation to State and local government, and the private sector.

Then we viewed all of our approaches from the context of what action the Secretary needed to take.

We knew the Secretary wanted a strategy for action. He had, and still has, the job of determining resource allocation. As you know, there is only so much time, so much money, so much personnel, and many more problems than can be handled with the amount of time, money, manpower resources available. Thus the resources have to be divided or allocated on some basis of priority need.

We found that the goals which were being set were being done so at the lower levels of the Department. They didn't seem to relate to any overall policy.

The first thing we had to do was to identify the enemy. The enemy was the environmental insults which occurred in the air, water, on or in the soil, and in the space that humans occupy.

The second thing we decided was where the action should take place. We decided that the direct operations to prevent environmental decay or restore environmental quality ought to be done by the city or in high density urban areas by a metropolitan regional body. Where State lines cut through an urban area, regional bodies should be established to do the job.

The task force did not deal with a State role. But I would say it should be to supplement funding local action programs and to prevent budding urban areas from falling into the same traps existing ones are in.

The State does not need to play a direct role in local action programs, nor should it. The State does not need to be an intermediary between Federal support and local action, and it should not be.

I have long heard the plaintive word that the State must be involved in the planning of environmental improvement in urban areas because of the effect on the rest of the State. All I can say is that the effect on the rest of the State can only be positive. Let the State enter the battle for environmental improvement with its money and its support.

The Federal role we suggested should be to provide the resources which no local or State agency can provide itself. This is essentially research, establishment of criteria, manpower development, and compliance leadership. The Federal Government's direct action role should be limited to those things which are clearly beyond local reach, such as automotive exhaust emission control or consumer protection. But its role should be extended to include authority to take action if local units can't or won't.

Mr. DADDARIO. Mr. Linton, in talking about establishment of criteria, you have gone into problems that the States have and that some of these problems do cut across the State-city lines, as of course they do. Are you talking about the establishment of criteria on a basis of various standards, or do you have this capability? Can you, in fact, meet the criteria requirements of one area without coming to a judgment that will perhaps place you in the position where criteria for the setting of regulations in other places should be higher or lower?

Mr. LINTON. It may be—and I am speaking in terms of standards rather than criteria—that a standard in one area may have a deleterious effect on another area because the standard is either too high or too low. Therefore, I think it is correct to establish a range of criteria, that relates to every conceivable, and possible development that can be evaluated in terms of standards.

My position on the State role does not eliminate a coordinator responsibility. All too often I think we find, that the approach now is to attempt to balance out the allocation of resources, rather than apply the resources that are available to the areas of most severe need.

Mr. DADDARIO. You believe that the agency involved ought to have flexible approach to this.

Mr. LINTON. Absolutely.

The task force believed that the private sector must play a cooperative role with the Federal Government.

Having identified the enemy and what the roles of the Government were in dealing with this enemy, it became a great temptation to deal from there on in generalities. How easy it would have been to set as the goal "defeat the enemy" and then go home, or to make recommendations like so many reports such as "we need better Federal-State relations."

The task force felt that there were plenty of others who could rapidly set out general philosophical goals.

We decided someone had to start with quantitative goals, and so we did. We set out 10 of them. We did it because we felt a strategy recommendation was meaningless unless it were pointed at some specifics.

There is nothing sacred about these goals stated in the report. They were thought to be most appropriate at the time we enumerated them as base points to test the effects of allocating resources. We expected they would give way to changing circumstances; and, if left to stand long enough unacted upon, would become outdated.

But goals of this nature are needed if the Department is to apply a strategy.

Outside of appropriations, only four of the goals required legislative approval; and two of those, water supply and waste management, called for a modification of existing authority.

The only new legislative authority would be for control of materials, trace metals and chemicals and consumer protection against health and safety hazards of appliances, clothing, food, and hazardous substances.

To undertake this responsibility would not, in my opinion, be as difficult as it seems at first glance, providing two ground rules are accepted.

One, the first standards set will not be the only standards set. Standards for these materials will have to be changed as new data and information on their effect on health is developed. The statute authorizing such a program will face the Congress with a basic public policy decision, to err on the side of caution or err on the side of economic expansion. I do not suggest it is an easy decision to make. But we need to make it, and to start the learning experience necessary to protect humanity from itself.

I believe that many of our environmental problems will be solved only by trial and error. The sooner we get started, the more experience we will havein trials and errors.

The second ground rule will be the establishment of a number of independent nonprofit testing organizations jointly underwritten by government and industry. These will have to adhere to rigid controls on its objectivity. But they are essential if many medium-size and small firms are to survive under the legal requirements of a consumer protection goal.

The Federal Government should devote its efforts to setting standards, reviewing the data submitted by the independent testing organization for a product to be marketed, and enforcement. It would fall upon the manufacturer to prove safety and the testing organization to document the proof.

I would like to turn now to what I think is the most essential aspect of the task force report—the environmental protection system. Without it, in my judgment, strategy means nothing.

The strategy we recommended was very simple. It was to isolate the environmental insult by degree of severity and attack it with an evolving technology.

To do this, the system is mandatory. The system was obvious once we looked at the functions being exercised by the environmental health agencies of the Department. These functions were research and development, determination of criteria and standards, enforcement, manpower development, public awareness, and intergovernmental relations.

But these functions were not integrated toward a policy of reaching quantitative goals.

We recommended a system which would first, through a research surveillance program, isolate any and all environmental insults individually or synergistically; identify their source, and their composition; and, second, measure and begin to uncover their effect on human health and welfare.

The data from this program would then pass as developed to the environmental design program, where it would be converted into a range of criteria that would incorporate concern not only for health but the socioeconomic factors as well. With this data, Government or Government authorized agencies would set a dual-level standard. The first level would be the immediate requirement based upon the minimum health needs and technology available. The second level would be the next desirable and accomplishable level.

As a result of these standards, the next program in the system, applied technology, would act to advance the state of the art so technology could provide the higher standard.

Finally, the fourth element of the system, compliance, would insure that applicable standards were being adhered to.

The two fundamental aspects of this system, which must be radically changed from present Department approaches if such a system is to work, are the Department's ability to set criteria and standards and ability to conduct an applied technology program. In fact, disregarding even this proposed system, without radical changes in the Department's ability to handle these two programs, nothing it does in environmental protection will amount to much.

Criteria cannot be developed and applied by a variety of agencies. There must be an integration of information, a central source for what I call biblical material. The criteria issued will provide a basis for setting standards and, unlike religion, if this is to work, there can be only one bible. The basic concern is for health responsibility; for criteria development should be within the Public Health Services.

But neither that agency nor any other, Federal or non-Federal, can today do the job of developing criteria, the way it need to be done. And they will not be able to do this job until it is understood what a vast and difficult job it is. Substantially more manpower than now available in the Department, including ecologists, economists, sociologists, behavioral scientists, as well as physical scientists, engineers, and medical doctors, will be needed.

But more than manpower requirements is the need to understand that criteria cannot be static. It must be subjected to continued evaluation. There must be a constant effort to improve the validity of data upon which criteria is formulated.

The data for criteria will be developed by scientists. The public policy decisionmaker must be assured of the validity of that data.

Right now, I, as a public administrator, am not convinced that the scientist and technician can provide the answers necessary to establish criteria and standards in anything more than rudimentary form.

Let's look at ambient air quality as an example. Let's start here with me acting the role of a politician with no technical background. I would be aware of a general dissatisfaction among my constituents with the condition of the atmosphere; and so I would call for clear air.

That means something at the polls, but nothing in terms of action.

Now, let me assume the role of the appointee of the politicians, I have to turn the campaign promise into action. I am still a nontechnician, so my analysis is in terms of common language. I find out that people think they want the air clean enough so that they don't sneeze, get matter in their nose or eyes, experience eyeburn, or develop emphysema.

I turn now to the scientists and I say, "What are the things in the air which cause this discomfort?" Among the things that cause the problem, I am told, are sulfur oxides.

Now, I tell my scientist, "I want to set a standard which will eliminate eyeburn." Thus elimination of eyeburn becomes a criteria for the standard, as far as I as a public administrator, am concerned.

But, that doesn't help us in terms of control. So my next question is, when and under what conditions does sulfur oxide cause or contribute to causing eyeburn? Now the answer to this question provides us with the preliminary criteria data for setting standards. I must also have economic data. And, for the matter to be complete, examination of the question should have been done in terms of climate condition, demographic condition, and geological conditions.

When we sit down to set standards, we find that the technician has given us a range of measurable volumes of sulfur oxide which contributes to eyeburn and so we can set a standard for volumes of sulfur oxide that relates to a criteria of no eyeburn.

Mr. Chairman, that is an oversimplification of the problem, because obivously you don't have a single criterion, you don't have a single element in the earth to deal with. But I wanted to use that for practical illustration purposes.

I don't want to be on record as citing that as a unique or specific problem.

Today we will set standards essentially in an arbitrary manner as we have limited ability to develop criteria. But this is no excuse not to move ahead with standards and criteria, for we need the experience of developing criteria and standards. Nor can we wait until we have perfected our ability to act.

I would prefer to act on little knowledge and err on the side of caution in protecting human health and welfare. My plea here is not to avoid action until we have perfected our ability to develop criteria and set standards.

I would like to turn now for a moment to applied technology.

A useful applied technology program means involving industry. To a minor extent, this is being done. Much more involvement is required.

The Department of Health, Education, and Welfare should be using industry as Defense and NASA have used it. And the Congress should write a basic procurement law to cover HEW's needs to use industry.

We ought to be spending at least $1 billion a year on contracts with industry to develop the hardware necessary to control and prevent environmental deterioration. But the Department now can't do this. It lacks from the Congress a clear indication of public policy in this area. That policy must cover patent problems. It must deal with sole-source procurement. It must deal with research competition. It must deal with marketing problems.

The Department of Health, Education, and Welfare certainly is different from Defense and NASA in that HEW is not the ultimate consumer of a mass product for environmental protection.

Nevertheless, the Department alone can provide the leadership to bring about the technological advances necessary to maintain a high-quality environment and allow for economic expansion.

But we must face the reality that it is going to cost money, for nothing is free—neither air nor water, and certainly not soil or space.

We cannot now measure the cost of using resources for waste assimilation, because we don't know the true effects; nor can we correct it properly, because we are not creating the technology. We had better do both now.

Mr. DADDARIO. Mr. Linton, you say that HEW differs from Defense and NASA and that you could not be the ultimate consumer of the mass product for environmental protection.

Isn't this one of the selling arguments that you have, that in this instance the public would be the consumer?

Mr. LINTON. That is correct.

Mr. DADDARIO. It fits within our competitive economic system.

Mr. LINTON. That is correct.

Mr. DADDARIO. The $1 billion could generate a great deal of activity which could in the final analysis run into billions of dollars.

Mr. LINTON. Absolutely. In fact, Mr. Chairman, I feel it possible to devise the means involving Government and industry development to the point where the investment by the Government would eventually be returned by the economic activity which is created protecting the environment.

I think some direction in this effort has been made by FAA, and that is simply that where the Government provides the research funds to develop new technology, which is then disposed of on an open market, that it receives off the top the amount it put into the direct research, which could then be used in a continuing fund for advancing the state of the art and evolving new technology.

We could conceivably reach a point where it required very little additional congressional appropriations to maintain this fund and keep moving technology ahead.

Mr. **Daddario.** I think that those problems could be worked out.

You mentioned some were patent problems. It is a matter of policy how this relationship could be developed.

We are learning how to handle this better in every agency of Government. Experience, developed in these last few years, should enable us to come to a policy determination as to how this relationship is to work for the benefit of our society.

You talk about what is needed here; more manpower, unavailable in the Department, which I expect would include other agencies, and necessity for criteria.

You don't touch upon how it is structured and don't recommend how it could be better structured. Must I assume from what you have said that you are happy with the way we are handling all of our environmental problems in the Government?

Mr. **Linton.** No; I don't think you would assume that.

Mr. **Daddario.** You don't touch on it.

Mr. **Linton.** You mean structured in the sense of the way it is organized?

Mr. **Daddario.** Structured in the way it is organized.

Mr. **Linton.** I don't touch on it, Mr. Chairman, because my own feeling about organization is that it is generally an extension of the personality of the people assigned the responsibility of running the agency. I don't think organization, per se, really makes that much difference in the effectiveness.

I would say that certainly the present structure of HEW could be improved.

When we developed the report——

Mr. **Daddario.** Before you get going any further in this—I don't know I agree with your definition of how management can be improved.

How about the relationship HEW has with Interior and other agencies which are also involved in this research? The competition does exist as to who is going to get the biggest share of the problem.

Mr. **Linton.** I did touch on that, Mr. Chairman, by my comment that I felt at the moment that the responsibility, the basic, essential responsibility for the evolution of criteria, should rest with the Public Health Service. I think the health effects are the predominant concern. And as far as the relationship between the agencies——

Mr. **Daddario.** I don't mean to limit you. I was only referring to your approach to the management. I do think, as we get advice from the agencies in the environmental area, it must necessarily include not only that work which is being done in the agency you happen to be associated with at the moment, but also its relationship conversely to other agencies of Government, and the problems which exist as a result of this relationship.

Mr. **Linton.** I agree with you, Mr. Chairman, and in the report we did address ourselves to this problem.

We did recognize the existence of the problem, of the competition.

I did not speak to it specifically in this statement this morning, but my feeling is that a great deal of the competition, a great deal of the difficulty in coordinating among departments, results from the lack of specific objectives and goals. And if they have a problem in HEW you have even a greater problem in integrating the objectives of several departments in working together.

Mr. **Daddario**. I understand that, but because we have problems in this area, it doesn't mean that it has to be that way. You do have non-health-related environmental problems. Criteria has to be established about those things, and HEW, using your own yardstick here, ought to be in charge of the health area through the Public Health Service. Adjustments need to be made.

Mr. **Linton**. Right.

Mr. **Daddario**. We are trying to make recommendations about it, because we recognize some of the problems are those imposed upon us as a result of congressional structure.

Mr. **Linton**. Well, that is true.

Mr. **Daddario**. It is extremely complicated. We have to look at our problems here and try to work out a way to handle it so that we can prevent pressures being put on you which may result in bad management decisions.

Mr. **Linton**. That is correct.

Mr. **Daddario**. We can't do it, unless we hear from you as to what the problems are. We may come to some judgments which could be improved if we could get an interpreation about the situation from those of you who work in it from day to day.

Mr. **Linton**. Well, again, Mr. Chairman, I am not sure that it really is that difficult to function under the present setup.

Mr. **Daddario**. I think it is difficult to function the way we would like it to be. Obviously you are functioning, but that is not the answer.

Mr. **Linton**. Let me add the caveat then: I don't think the present system really prevents substantial improvement in functioning the way we would like it to be.

I would agree that it would be a great improvement to resolve the appropriate roles among Federal agencies and to create a mechanism that allowed them to cooperate together.

I am not sure that there is that much friction or competition among them, and I am more concerned with the lack of quantitative goals at the top levels in the departments as a means of developing that cooperation. I think until, for example, the Department of Health, Education, and Welfare, does establish for itself some very specific measurable goals on a time basis, it is extremely difficult for it to relate to HUD and Interior's and Agriculture's interests.

I think the problem is an awful lot of generalities that are used as goals, and that these leave openings for a great deal of interpretations by separate agencies that then have to be resolved.

Mr. **Daddario**. Well, we could chase that one around for a long while.

What you have said has been helpful in that regard.

The goals of your report—materials, trace metals, chemical controls, et cetera.

Can you discuss how such a concept would be implemented?

Mr. **Linton**. It assumes first of all that the Congress passes legislation which authorizes this, and it then would become necessary for the manufacturers who are now marketing, or using materials, trace metals, and chemicals, falling under this definition, to provide to the

Department necessary data to establish their levels of safety and recommend the kinds of decisions that need to be made, for the Department to develop the criteria and establish standards to apply to items.

As I said in my statement, if it is to be achieved, if this kind of a goal is to be achieved, it seems almost mandatory that there have to exist in one fashion or another something which we did not at the time of writing this report really conceive, and that is a mechanism for testing, for evaluating the data, the development of data.

I spoke of the independent nonprofit testing agencies that would have to exist. I don't know if that is the only answer or the best answer to it. But the smaller, medium-size companies who do market or use these type of things, find themselves in extremely difficult situations if they had to conduct the testing themselves. I don't think it is possible to create within the Department an agency, with the manpower, and with the capability to do the entire job. I don't think we have the resources to devote to that.

But this is essentially the concept of how that would be implemented.

Mr. Daddario. Would some kind of an approval, in testing the mechanism, be made?

Mr. Linton. Right.

Mr. Daddario. You don't think the product liability laws as they presently exist assure the quality of protection that you are interested in?

Mr. Linton. No, sir. Our judgment was that more serious than at present, would be the developments of the future, and that if the changes that have occurred in the last 25 years in the sophistication of our products and our processes, are a test the sophistication will be even greater in the years ahead. And that a safety mechanism is required to, as best as possible, protect human health and welfare. It was certainly not believed, and I don't believe, you are going to guarantee that under no circumstances will there be any products or materials or trace metals produced and marketed which may not cause a problem. I don't think human beings are capable of solving and protecting themselves in an absolute fashion against anything. This was not designed as some people have suggested subsequently that this was an absolutely safety measure. It is designed as a fire department, as the best means of protection, but with clear understanding it is not going to guarantee safety.

Mr. Daddario. Last year, Mr. Linton, Chairman Harris raised the point that I think leads into your hopes and ambitions for goal 3, on garbage and solid waste disposal. He wanted to make it clear that the purpose of the program was not to subsidize the solid waste disposal. He said that the Federal Government is not going to assume the responsibility and the obligation for disposal of garbage and all solid waste, and so forth. He wanted to make sure the purpose was to do some research in the area and that was all.

When you talk of grant and aid programs for solid waste disposals at the local level, aren't you in fact moving in the direction of subsidizing such disposal contrary to Mr. Harris' limitation?

Mr. Linton. Yes, sir; we did. We did move in the opposite direction. The judgment of the task force was that the experience in the water pollution field, of providing grants for sewage treatment plants, was an appropriate direction for the Government to move in. Assisting the local governments in handling the increasing problem of disposal of solid waste in the same manner is valid.

Without questioning the validity of Senator Harris' position, but merely expressing myself in the terms of the task force's feeling, the judgment was that the city governments, county governments, and regional agencies, were not able at this time to carry the full burden of the financing of governmental installations to dispose of solid waste. This is true whether by incinerator or landfill, or whatever technique is developed, this wasn't designed just simply for creation of incinerators. Our view was that it was appropriate to do this in solid waste, as it was to do it with sewage treatment plants.

Mr. DADDARIO. I raised that only because in the formation of the legislation, Senator Harris, who had a great deal to do with it, raised these points, and because of the direction you are moving in. I think it ought to be thought about seriously.

Mr. LINTON. In 1965, the solid waste disposal act was recommended to the Congress by the administration. At that time I was chief clerk and staff director of the Committee on Public Works of the Senate. We revised that legislation to include a grant-in-aid construction program for incinerators. It was taken out after the Department convinced the chairman of the subcommittee handling the bill that they needed to spend several years in research before investing substantial amounts of moneys in incinerators that would become outdated.

I think it has become apparent now in the Department that by the time they reach the point of developing their research, the facilities that would have been built in these few years would have outlived their economic usefulness anyway. The result now is that we have neither. And I think that we are much better off spending some money over the next few years building incinerators where they are really needed, and then replacing them in 25 or 30 years, than we are waiting until we have produced the technology that eliminates the needs of these incinerators, or provides for improved incinerators.

I think there is too much of a tendency to wait until we have perfect answers before we act. With the result, we go for an extended period of time with less than what we could do at the moment.

Mr. DADDARIO. I think that is, of course, a tendency.

Mr. LINTON. We don't do it, Mr. Chairman, in the Defense Department. There we go right ahead, under the euphanism of national security, and we spend millions and millions and millions of dollars on equipment and material which within a few years is outdated or discovered to be of no value.

Mr. DADDARIO. Precisely for that reason you can't use the Defense Department as an analogy, because you don't have that room to move around in. Therefore, you have to do it in a differentt way.

Mr. LINTON. We don't because we apparently, as human beings in the United States, just don't place protection of our own health and welfare at the same level as the protection of our national security.

Chairman MILLER. Is that the responsibility of Congress or should the medical and the biological professions, through the medium of education, tell him about that?

Mr. LINTON. Absolutely, Mr. Miller.

Chairman **Miller**. I think this is a part of the problem.

Mr. **Daddario**. Because I raised the question of solid waste disposal does not mean, we ought not to be giving help. This is of interest to many communities who have very limited funds with which to work.

Mr. **Linton**. Right.

Mr. **Daddario**. Yet I do think we have to recognize that we ought to be moving ahead in certain areas, incinerators could very well be one of them. We ought to be careful that we do not move ahead in certain areas where we are not able to accomplish much and where great expenses can fall on us, just because those areas happen to be extremely popular. Somewhere along the line a whole series of judgments are needed. None of them, even the incinerator area, can be made so that we should go ahead in every case. There may be places where we should be helpful and other places where we ought not to be.

Mr. **Linton**. I agree with that. That is a part of the thing that complicates the problem, you can't find a universal solution.

Mr. **Daddario**. Well, Mr. Linton—Mr. Chairman, do you have any further questions?

Chairman **Miller**. No, I want to congratulate Mr. Linton on his statement. I find myself in full agreement with a great deal of it.

Mr. **Linton**. Thank you, Mr. Miller.

Mr. **Daddario**. We are pleased, of course, Mr. Linton, to have you here, and with the help you have given. We were anxious to hear from you.

We will, I hope, be able to take advantage of you as well as the other witnesses, by contacting you and filling out your testimony so that we can make the record as intensive as possible.

Mr. **Linton**. Mr. Chairman, I feel an obligation to do that, since I have learned so much over the last several years from what you have done with the committee, that I am only happy to see if I can give some of it back in terms of some new ideas. Please feel free to call on me.

Mr. **Daddario**. It is a mutual enterprise. Thank you.

Mr. **Linton**. Thank you very much.

Mr. **Daddario**. We appreciate having you here.

We have Dr. Gershinowitz with us this morning, and I know we are running a little bit late, but we would like to hear him if possible. We would appreciate it if you could come forward and see how much of your testimony, Dr. Gershinowitz, we can get out of the way.

I regret doing it this way, but we have had some scheduling problems.

Dr. **Gershinowitz**. I am quite happy to have this opportunity to at least start on this presentation, Mr. Chairman.

(The biography of Dr. Gershinowitz is as follows:)

DR. HAROLD GERSHINOWITZ

Harold Gershinowitz, chemist, was born in Brooklyn, New York, August 31, 1910. He holds the B.S. from City College of New York (1931), the A.M. (1932), and the Ph. D. (1934) from Harvard. He is a fellow of the American Association for the Advancement of Science, and a member of The American Chemical Society, the New York Academy of Sciences, Phi Beta Kappa, and Sigma Xi. From 1953 to 1962 he was President of Shell Development Company. He then was elected a Member of the Board of Directors, Chairman of the Research Council and Research Coordinator for the Royal Dutch Shell Group of Com-

panies. Dr. Gershinowitz retired in 1966. He is now Chairman of the Environmental Studies Board of the National Academy of Sciences and the National Academy of Engineering, consultant to the Organization for Economic Cooperation and Development (Paris), and affiliate in the Faculty of the Rockefeller University.

STATEMENT OF DR. HAROLD GERSHINOWITZ, CHAIRMAN, ENVIRONMENTAL STUDIES BOARD, NATIONAL ACADEMY OF SCIENCES, NATIONAL ACADEMY OF ENGINEERING

Dr. GERSHINOWITZ. My name is Harold Gershinowitz and I am Chairman of the Environmental Studies Board of the National Academy of Sciences and the National Academy of Engineering.

I am particularly pleased to have this opportunity to present to you this report on the activities of the Environmental Studies Board.

The existence of the Board itself is, in a very large measure, due to the desire of the two Academies to provide a scientific-engineering resource for the Federal Government, and that desire was very much stimulated by the interests of your subcommittee in the problems of the environment, particularly as exemplified in the hearings which you held in 1966. We were very honored, Mr. Chairman, when you attended our initial meeting on the 27th of January of last year.

Mr. DADDARIO. I was honored to be asked, Dr. Gershinowitz.

Dr. GERSHINOWITZ. After rereading the initial draft of this report, which I am making to you, I felt a bit apologetic about the emphasis which I had placed on matters of organization, but after hearing the tenor of discussion this morning perhaps it is what you are interested in hearing.

I do give a substantial amount of detailed information about the origin of the Environmental Studies Board, the responsibilities assigned to it, and the organization through which it operates. Most of this is included, because the way in which the Board has found it desirable to operate is indicative of the character of the problems with which it is faced.

The first thing that one can say about any one problem of the environment is that it cannot be considered in isolation. Air pollution cannot be considered without also examining fuel resources, solid waste disposal cannot be discussed without reference to potential air and water pollution. Both in science and governmental organizations knowledge and responsibilities are divided in ways which make difficult comprehensive examination of either causes or remedies. Much previous work, both in the realms of technology and of policymaking, has been done without adequately taking into account side effects and interrelationships.

The Environmental Studies Board with its broad charter has considered it essential to take these interrelationships into account. Much of what may seem to be a preoccupation with organization which has taken up much of our time for the first 6 months of our existence has been due to the need to provide mechanisms which would make it possible to include interactions. This need is clearly reflected in the opinions and suggestions currently being reviewed by the Environmental Studies Board, and which constitute the major part of this statement.

The responsibilities and composition of the Environmental Studies Board were described in the announcement made on March 3, 1967, by Dr. Frederick Seitz, President of the National Academy of Sciences, and Dr. Eric Walker, President of the National Academy of Engineering. A copy of this announcement is attached as exhibit A. One of the original members of the Board, Dr. John Perkins, resigned in June 1967, when he left the University of Delaware to become president of Dun & Bradstreet, Inc., and Dr. Harvey Perloff, economist on the staff of Resources for the Future, Inc., was appointed to take his place. Subsequently, two additional appointments to the Board have been made. Dr. Hendrik W. Bode, professor of systems engineering at Harvard University and formerly vice president of the Bell Laboratories, and Dr. G. Evelyn Hutchinson, professor of zoology at Yale University.

At its first meeting the Board discussed its responsibilities and functions. I quote from the minutes of that meeting:

> It was generally agreed that the Board may:
>
> a. Serve as a focal center of the NRC activities underway or potentially so, in the broad field of environmental problems.
>
> b. Serve as a source of recommendations for additional work to be done either by the two Academies or by a branch of the Government.
>
> c. Serve as a central source to serve the legislative and executive branches of Government which may come to the NAS–NAE to find out what might be done to help solve problems, or how to work cooperatively with agencies.
>
> d. Provide a means of contact between local agencies and centralized centers of scientific activities, such as the Academies.
>
> e. Serve as an "impedance-matching device" in the sense of promoting understanding and cooperation among the scientists, engineers, lawyers, statesmen and the man-on-the-street concerned with the complex problems of man's environment. By way of this Board the language from one group to another might well be translated, and it was agreed that this is one of the most important things the Board can do.

You can see, Mr. Chairman, we are taking seriously the charge that you have put to the scientific community in your previous statements and reports, and we do think that it is our responsibility to include not only the physical and biological sciences, but also the social sciences and economics, and all the political implications of the problems of the environment.

It was agreed that the Board would work through the divisions of the National Research Council to the maximum extent. The Board, of course, has the authority to establish committees and panels as required to carry out its responsibilities. The Board felt it should call on the services of behavioral scientists, political scientists, economists, and ecologists as well as physical scientists and engineers.

The concensus of the Board was to limit its considerations to problems arising from the physical interactions of the individual with his environment. It was agreed that the Board would look not only at possible short term solutions but would also concern itself with possibilities which go beyond the technical/legal solutions now possible.

We also decided that although our charter covered the whole range of environmental problems, those concerning pollution were the most most pressing and that we should devote our initial attention to them. It seemed to us that one of the urgent needs was to provide a mechanism whereby current engineering knowledge could be made available to the Congress and the executive branch. One of the reasons for the establishment of the National Academy of Engineering was to provide such assistance to the Federal Government in the same way as scientific knowledge had been made available through the National Academy of Sciences. The following excerpts from a letter from me to the other members of the Board describes the principles and procedures which we have adopted.

At our last meeting we discussed at some length the matter of subcommittees which might cover the wide range of problems which are encountered in dealing with pollution and its interrelationships with natural resources. We approved in principle the proposal of the ad hoc committee of the NAE that a committee be set up to deal with the USPHS Office of Solid Wastes and to continue the discussion of possible projects to investigate. The Board also agreed that similar committees should be set up to deal with air pollution and water pollution. This would have the advantage of permitting concentrated attention to be given to existing or anticipated problems in a manner which is organizationally compatible with the existing division of responsibility among the agencies of the Executive Branch (and to some extent within the Congress as well).

In our discussions we have continually emphasized the interdisciplinary character of the problems of environmental pollution, not only among the physical and biological sciences but the social sciences as well. At the same time I think that we must recognize that there are many immediate and urgent instances in which sound quantitative engineering thinking should be made available to the Government as soon as possible.

It seems to me that we are now faced with a kind of planning and organizational problem that is very similar to those encountered in industry. The Government is already committed to a program of regulation and enforcement which is underway. As a basis for this program it must make use of the best data available, and where not enough data are available it must make provisions for the securing of essential data as soon as possible. In a manufacturing industry this would correspond to the final stages of design and construction of a new plant. Although it may be found that some research is necessary, there is such a commitment of resources and such a time schedule that whatever research may be essential must be done on a crash basis. Even though it may be known or felt that additional research would result in an improved process, it is recognized that it would be economically unsound to delay the progress of the work while waiting for the ultimate. Substantial changes must await the construction of a second plant.

This is the kind of work best done by engineers. I think that it is important that the engineering point of view be the dominant one. I think, however, that the very specific nature of the present crisis should be emphasized and that the proposed ad hoc committees be clearly instructed to confine their attention to the immediate short-range problems, with the understanding, of course, that they still have a responsibility for recognizing and defining problems which will need more extensive study.

It is essential to differentiate and separate the responsibilities for immediate technological assistance and long-range planning. Thus while it is important that the two Academies set up an appropriate relationship with those executive and legislative agencies whose immediate responsibility is to propose, enact, and enforce regulations concerning the protection of the environment and of natural resources, it is likewise essential that other bodies be set up or designated with the responsibility for studying the longer range aspects of the subjects involved.

Mr. **Daddario.** Do you have anything in mind in regard to these committees with long-range objectives which you speak of?

Dr. **Gershinowitz.** Yes, I will describe this in a moment.

We have agreed that the most effective way of interacting with what may be called the operating agencies and legislative committees is to parallel their organization. Specifically, since the field of pollution is conventionally divided into air, water, and solid wastes, the proposals that have already been made that the NAS–NAE set up ad hoc committees with these areas of responsibility is the proper one. Nevertheless, it is clear that these committees will have so much to do to interact with and satisfy the demands of the governmental agencies with whom they will deal, that they will have little opportunity to look at the problems in broad perspective and in relationship to each other.

I do think that there exists within the actual and potential structures of the two Academies, and within their relationship with the National Research Council, not only adequate but unusual opportunities for achieving the kind of interaction between applied research and its utilization that is essential for the optimum application to our national problems of the resources of our national community of scientists and engineers. I do not wish to belabor the analogies with industry, but I believe that it is true that only in a few larger research-minded companies and in our more successful mission-oriented national laboratories that basic research, applied research and engineering application have been able to work in such a manner that the efforts of each both benefit from and reinforce the others. The responsibility that has been assigned to us involves the first major interaction and cooperative effort of the NAS and the NAE. If we can develop a satisfactory method of operation and cooperation we will have achieved something which in the long run may be even more important than our specific task.

As I said earlier, the charter of the ad hoc committees should limit them to the known and the immediately attainable. The three chairmen, presumably all engineers, would become members, ex officio, of a committee, whose other members, also ex officio, would be the chairment of the other committees which are involved in the problems related to the environment.

That is the mechanism for the long-range study, Mr. Chairman.

This committee would report to us, the ESB, and through us to the loci of planning in the Executive Branch and the Congress. It would be the responsibility of this committee of chairmen to propose and recommend the longer range and interdisciplinary activities, the need for which arises from the projects underway.

I also have remarks later on as to what might be desirable in the interdisciplinary activities.

It would still be the responsibility of our Board to recognize and define and promote the studies in and interaction of physical and social sciences with each other and with the hard realities of politics and public opinions and pressures. Contacts with the Government relating to such longer range and complex problems would be made through our Board.

That, essentially, is a statement of the procedures we have chosen to operate under, Mr. Chairman, in this type of committee structure we have set up. I would now propose to discuss a few specific examples of what is happening in that realm.

As soon as one becomes involved in any one of the specific problems of the pollution of the environment it becomes apparent that no one problem can be treated in isolation. Methods for waste disposal, whether they are concerned with gases, liquids or solids, interact with each other; incineration of solids can cause contamination of the air, sanitary fills can cause contamination of water supplies, substitutes for incineration, such as maceration, can increase the load on water purification systems. Nevertheless, the technologies for the handling of gases, of liquids and of solids are fairly distinct from each other and furthermore, the delegations of authority and responsibility to the various Federal agencies divide this responsibility along the three lines of air, water and solid waste (with, unfortunately, some overlapping).

In spite of our consciousness of the interrelated aspects of these problems we thought it essential to provide engineering in these conventionally separated compartments in order to facilitate communication with those responsible for each of these areas.

We have, accordingly, set up four ad hoc, engineering oriented, committees to deal with air, water, solid wastes and noise. The membership of each of these committees is given in exhibit B.

(The documents, exhibits A and B referred to, are as follows:)

EXHIBIT A

NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

WASHINGTON.—Citing the rapidly increasing national concern about the quality of the environment, Dr. Frederick Seitz, President of the National Academy of Sciences, and Dr. Eric Walker, President of the National Academy of Engineering, announced today the establishment of an Environmental Studies Board to coordinate all activities of the two organizations in this area, to work directly with the legislative and executive branches of the Government in attacking related problems, and to initiate broad new studies when necessary.

A major purpose of the Board is to provide a national focus for broad interdisciplinary efforts toward reducing or controlling pollution and other environmental problems.

Dr. Harold Gershinowitz, former Research Coordinator and Chairman of the Research Council of Royal Dutch/Shell, and former President of the Shell Development Company (retired), is the chairman. Dr. Gershinowitz received his B.S. degree from the City College of New York, his A.M. and Ph. D. degrees in chemistry from Harvard University, and did postdoctoral research at Princeton, Columbia, and Harvard Universities. He has been active in academic affairs, serving as chairman of the Council of the Harvard Graduate Society for Advanced Study and Research and a member of the visiting committees to the Department of Chemistry and the Division of Engineering and Applied Physics at Harvard, and to Departments of Geology and Chemical Engineering at Massachusetts Institute of Technology.

Two major considerations prompted the decision of the Academies to establish the Environmental Studies Board:

Recent reports on pollution abatement have emphasized the interdisciplinary nature of environmental problems and recommended that coordinating bodies be set up. The establishment of such a board within the Academy structure was specifically recommended in a 1965 report of a panel of the President's Science Advisory Committee, *Restoring the Quality of Our Environment*, prepared under the chairmanship of Dr. John W. Tukey. It was one of several measures suggested to provide for early identification of pollution problems and to avoid gaps and imbalances in their study.

Five of the eight Divisions of the National Research Council—an operating agency of the two Academies—are currently studying problems directly concerned with pollution of the environment. Among the activities are studies of the potential effects of pesticide residues, food chemicals, hazardous materials, sonic boom, medicated feeds, and the work of committees on water, atmospheric sciences, geography, food protection, and toxicology. Many other problems under study also relate to the environment, and it seems more than probable that the Academies will be asked to take on additional work in view of the mounting concern being expressed by Federal, state, and local governments and the public at large.

The Environmental Studies Board has been given authority by the Councils of the two Academies to review ideas, requests, proposals, and programs directed to them concerning pollution and other stresses on the environment. In addition to coordinating National Research Council activities currently underway on environmental problems, the Board will also recommend additional work to be done by either the two Academies or by an appropriate branch of the Government.

A major responsibility of the Board will be to promote understanding and cooperation among scientists, engineers, political leaders, and the general public concerning the complex problems of man's environment.

Members in addition to Dr. Gershinowitz are Dr. Wallace L. Chadwick, Vice President (retired), Southern California Edison Company; Dr. Frederic A. L. Holloway, President, Esso Research and Engineering Company; Professor Robert Morison, Director of the Division of Biological Sciences, Cornell University; Dr. John Perkins, President of the University of Delaware; Professor Roger Revelle, Director of the Harvard Center for Population Studies; and Dr. Chauncey Starr, Dean of the College of Engineering, University of California at Los Angeles.

EXHIBIT B

NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

ENVIRONMENTAL STUDIES BOARD

MEMBERSHIP—NAE–NRC COMMITTEES ON WATER QUALITY MANAGEMENT, SOLID WASTES MANAGEMENT, AIR POLLUTION, AND NOISE

NAE–NRC Committee on Water Quality Management

Chairman: Dr. Edward J. Cleary, Executive Director and Chief Engineer, Ohio River Valley, Water Sanitation Commission, 414 Walnut Street, Room 302, Cincinnati, Ohio 45202

Mr. J. Floyd Byrd, Engineering Division, Proctor and Gamble Company, M. A. & R. Building, Cincinnati, Ohio 45217

Mr. James B. Coulter, Assistant Commissioner, Environmental Health Services, State Department of Health, 301 West Preston Street, Baltimore, Maryland 21201

Dr. Gordon M. Fair, Professor of Sanitary Engineering, Emeritus, 224 Pierce Hall, Harvard University, Cambridge, Massachusetts 02138

Dr. Mark D. Hollis, Chief Engineer, Pan American Sanitary Bureau, Regional Office of WHO, 525 23rd Street, NW., Washington, D.C. 20037

NAE–NRC Committee on Solid Wastes Management

Chairman: Dr. Donald N. Frey, Vice President, Product Development, The Ford Motor Company, Dearborn, Michigan

Mr. Frank R. Bowerman, Program Manager, Von Karman Center, Aerojet-General Corporation, 1100 West Hollyvale Street, Azusa, California

Mr. David J. Damiano, Acting Director, Solid Wastes Program, City Hall, Philadelphia, Pennsylvania

Dr. S. A. Hart, Associate Professor, Department of Agricultural Engineering. University of California, Davis, California

Professor Percy H. McGauhey, Director of Sanitary Engineering Research Laboratory, University of California (Berkeley), Richmond, California

NAE–NRC Committee on Air Pollution

Chairman: Professor Thomas K. Sherwood, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

Professor Merrell R. Fenske, Head, Department of Chemical Engineering, The Pennsylvania State University, 133 Chemical Engineering Building, University Park, Pennsylvania 16802

Dr. Robert L. Hershey, Member, Board of Directors, E. I. du Pont de Nemours Company, Dupont Building, Room 2088, Wilmington, Delaware 19898

(Other members to be appointed.)

NAE–NRC Committee on Noise

Chairman: Mr. Laymon N. Miller, Bolt, Beranek and Newman, Inc., 50 Moulton Street, Cambridge, Massachusetts 02138

(Members to be appointed.)

Each of these committees is now engaged in discussions with the appropriate agencies of the executive branch concerning actual or proposed contracts for advice and services; for example, HEW, AEC, the Appalachian Regional Commission.

It is the continuing responsibility of the ESB, however, to make sure that these committees interact with each other and do not make recommendations incompatible with each other.

One of the recommendations of the PSAC report, the Tukey report, "Restoring the Quality of Our Environment," was the following:

> We recommend that the following steps be taken to provide for early identification of broad problems involving pollution and to avoid gaps and imbalances in their study: (a) The Federal Council for Science and Technology should establish a Committee on Pollution Problems, composed of its own members. (b) The National Academy of Sciences—National Research Council should be asked to establish an Environmental Pollution Board, to be supported by government grant. (c) This NAS–NRC Board should meet jointly with the FCST Committee at least once a year to discuss newly recognized broad problems and current changes in the apparent importance of those previously recognized. (d) This Board and Committee should cooperate, through working-level mechanisms such as joint panels, to identfy the most pressing broad problems, and the general character of new knowledge or techniques needed to study or ameliorate them.

The Environmental Studies Board was established in part as a response to this recommendation, although our basic support is derived at present from the academies themselves rather than the Federal Government, as recommended in the Tukey report. The parallel committee of the Federal Council for Science and Technology, the Committee on Environmental Quality, was established in the spring of 1967. A joint meeting of the ESB and the CEQ was held on October 19, 1967, and arrangements were made for continuing close contact and cooperation of the two groups.

Dr. King, the chairman of the Committee on Environmental Equality attends many of our meetings, and Mr. Reed, the executive secretary of the ESB attends many of the meetings of the CEQ.

With the accomplishment of two of its first projects, the coordination and reorganization of the activities of the NAS–NAE–NRC and the establishing of mechanisms and channels for both policy and working level contacts with governmental agencies, the ESB and its commitees have begun to concentrate on their major responsibility. a response to the challenge so clearly stated in the report of your subcommittee of October 21, 1966:

> The scientific and engineering community should respond to the challenge of the pollution problem as a major opportunity to serve a public need. Work in

this field should be recognized as interesting, rewarding, and important. Proposals for organization, funding, and schedules which will assure the participation of excellent technical personnel in adequate numbers should be the joint responsibility of Government and private sector research and development leaders.

Accordingly, another aspect of our activity concerns our responsibility for getting the scientific and engineering communities involved in the problems of the environment. There is no lack of interest, rather the questions asked are how rather than why should we help. Each of the divisions of the National Research Council has had representatives attend one or more of our meetings and we have discussed with them the precise nature of some of the scientific problems which need solutions. We are working closely with the American Chemical Society, the American Institute of Chemical Engineers, and other professional organizations, to make sure that the effort is coordinated rather than fragmented. The interest of scientists and engineers is so great that small groups have sprung up in many places and in many disciplines each trying to make some contribution. You need have no fears about the concern of the scientific and engineering community nor their willingness to help. The problem at the moment is to break the major unsolved questions into manageable problems and to concentrate the effort on them.

I have already stated that the individual problems of the contamination of the environment are inextricably intertwined with each other insofar as the technical solution to one considered in isolation almost always complicates the solution to another. But there is complexity of other kinds as well.

Contamination of the environment cannot be adequately examined without taking into consideration the questions of availability and conservation of natural resources. Standards of purity of effluents cannot be set without taking into account the ultimate use or disposition of the effluent. The complexity of the relationships between the health of individuals and their environment is such that it is improbable that we will soon have incontrovertible evidence permitting one to set absolute limits of tolerance for contaminants. In such circumstances it is tempting to try to play safe, to set limits very low. In all of our human activities we take risks. We put up buildings and live in areas subject to violent earthquakes or hurricanes. We do most of our long distance travel by air. We do much of our shorter distance travel by automobiles. The problems of environmental pollution must be looked at in the same way, by balancing risk against convenience, against cost, against feasibility. Our solutions should represent an overall balancing of these and other factors such as recreational use of land and waters.

The charter of the ESB is a broad one and we have interpreted it broadly. We have recognized that the solutions to environmental problems involve not only the physical and biological sciences but also questions of law, of political science, of economics, of sociology, of psychology. There can be alternatives, for example, between institutional changes and technological solutions, for example, between a multistate-multimunicipality water basin authority which might provide a few centralized treatment plants and the treatment of all effluents individually at their sources. The feasibility of an institutional structure can thus determine the direction in which technological progress should be sought.

In a similar manner, it is obvious that the questions of standards and criteria will involve choices between alternative uses for land and for water. As in the case of institutions, the kind of technology required and certainly the cost of the technology will depend on the degree to which contaminants or refuse must be suppressed, which in turn depends on the end uses of the body of land or water used for disposal. One needs to know what are the real desires of the people, how much they are willing to pay for the satisfaction of these desires, both in money and in the sacrifice of other things such as convenience or accessibility.

The Division of Behavioral Sciences of the NRC is working with us on the examination of such questions. Such questions as how does the individual perceive the environment. What does he consider tolerable, desirable or undesirable? We have asked each of the engineering committees to compile a list of nontechnological factors which inhibit the application of known or existing technology.

So far we have a reply only from our Committee on Water Quality management, the other committees are preparing their replies. But the reply of this Committee on Water Quality is so informative and instructive that I think it is worthwhile quoting those parts which refer to institutions and legal procedures:

> It is neither prudent nor practical to continue to rely primarily on the promulgation of prohibitions governing discharges at individual waste sources for mitigating pollutional effects. This traditional approach is hardly suited for the exacting task of managing water quality. Management of quality invites consideration of a variety of technological alternatives (such as mechanical aeration of streams, low flow augmentation and programmed discharge of effluents) which alone or in combination offer promise of maintaining desired quality conditions at lowest social cost.
>
> Although this concept has been gaining recognition, its application is handicapped because the functioning of state and federal agencies is geared primarily for the exercise of regulatory activities. In brief, the need exists for revamped institutions that are empowered to plan, design, finance, build and operate facilities within a systems-context for the management of water quality.
>
> Opportunities for the creation of such institutions may be visualized within the framework of interstate compacts, conservancy districts, or special authorities. Some innovations are being developed, as exemplified by the Delaware River Basin Commission and proposed Susquehanna federal-state compacts; the recent creation of the State Pure Waters Authority in New York; the proposed Maryland Waste Acceptance Service Authority; and expansion of the role of the Miami Conservancy District in Ohio.
>
> The Water Quality Management Committee would also point to the desirability of an inquiry looking toward improvement of judicial practices. They do list a number of specific recommendations that perhaps should be looked at by lawyers, but I think since they really need legal attention, I would rather not cite them at this moment.
>
> In addition, the subcommittee would invite discussion of the merits or limitations involved in the establishment of quasi-judicial boards or commissions for the adjudication of pollution control cases.

I have outlined for you the scope of our responsibilities, the nature of the mechanisms by which we hope to fulfill these responsibilities and some of our more general views of the ways in which solutions to the problems of the environment should be sought. I should now like to describe for you some of the difficulties we have encountered in dealing with specific proposals for additional research and development. I shall cite two specific examples.

The first is concerned with the evaluation of the effects on human health and well-being of the contaminants of the environment. Both industry and government are actively engaged in such studies, but we think that both would benefit from an independent evaluation. We have formulated a proposal for such a study, which would involve both long-range effects of small amounts of contaminants and the effects of high concentrations for short periods. We will need financial support from both government and industry for this study.

We would then propose to use these data in combination with engineering and economic data to put forth clearly the feasibility and cost of achieving various levels of contaminant reduction. This would then provide a rational basis for setting allowable or desirable levels of contamination on a risk-cost-benefit basis.

Our ad hoc engineering committees are already engaged in the collection of the available factual data which are essential to these studies.

We look upon the combination of the medical and engineering-economic aspects of the problem as essential to the optimum solutions. We think that joint industry-government financial support of this work would emphasize and insure the impartial character of the review. We have already received an assurance of support for part of the work from the Automobile Manufacturers Association, and are approaching other industries for support as well, but we find difficulty in identifying the appropriate agency of the Federal Government which should be interested in supporting this work. The wide scope of the study transcends the interests of the Public Health Service. The inclusion of water as well as air brings in a multiplicity of Federal agencies with separate responsibilities for separate parts of the problem. There is no overall coordinating or integrating body to examine the kinds of policy questions which inevitably arise when one considers the problem of pollution as a whole.

The second case which we have had a similar problem in is in attempting to discuss a project concerning the evaluation of energy resources not only in terms of their availability and nominal cost but with respect to their potential contribution to environmental pollution. Again, there is no body or agency within the Government that has that broad scope of interest or responsibility.

Mr. DADDARIO. You don't believe your relationship with the Federal Council on Science and Technology allows you to look at it in this way?

Dr. GERSHINOWITZ. It allows us to look at the technological interactions of programs. It does not allow us to look at policymaking problems or problems in which one has to make choices, or choose alternatives in deciding criteria.

Mr. DADDARIO. You see this as sort of a vacuum which needs to be covered?

Dr. GERSHINOWITZ. We do, and I conclude my paper by reading that statement.

It is the consensus of the ESB and its committees that one of the most urgent and critical problems in environmental pollution is that of definition of standards and criteria. These standards and criteria should be developed from economic and technological bases as well as public health considerations. Because of the potentially controversial nature of such criteria they should be developed with cooperation and participation of industry, government, and nongovernmental institutions representing the public interest. The factual data on which the standards and criteria should be fixed should be developed by an institution or agency which does not have a responsibility for policymaking or enforcement of a particular aspect of the pollution-resources question. An agency that has served a similar function is the Bureau of Standards of the Department of Commerce. If a nongovernmental institution is considered preferable the NAS–NAE–NRC could be the medium for establishing such an institution.

I can conclude this part of my comments with the general observation that from the viewpoint of a board charged with surveillance of the whole field of the interactions of man and his environment, the problems involved seem of such complexity and involve interactions of so many diverse agencies of Federal, State, and municipal governments that serious consideration should be given to the establishment of a single coordinating, policymaking body within the structure of the executive branch of the Federal Government.

Mr. DADDARIO. Dr. Gershinowitz, your paper and your presentation have been excellent and will be extremely helpful to us. I thank you for your presentation.

You touched on municipalities and their part in this. How do you see the relationship between Federal and local governments?

Dr. GERSHINOWITZ. Well, Mr Chairman, in what I have said up to now I have been acting essentially as a spokesman for the Environmental Studies Board and its committees. My opinions about the interrelationship with Federal and local governments, however, are based on my personal experience and what I say now it that.

I will preface it with the remark that although my biographical statement shows that I was born in New York and am now a resident of that city, actually the major part of my adult life has been spent elsewhere. For 11 years I was a resident of Texas, and during that time gained an understanding of and sympathy with the principle of States rights. For nearly 30 years I was employed by a large, complext corporation, and my career was divided between central offices and outlying divisions. From these two backgrounds I developed a bias in favor of decentralization in delegation of certain kinds of responsibilities.

I think that one should make a distinction between the setting of criteria and standards and the specifications and mechanisms whereby these criteria should be met.

In a great many ways the problems faced by one community or one State are different from those of another; whereas, the determination of standards and criteria can best be done by the Federal Government, the determination of how to achieve these standards is usually best done at a local level. Local authorities can be remarkably ingenious in the disposition of the resources available to them. In addition, the feeling of creative participation stimulates and encourages the adoption of new methods.

The Federal Government has a very important role, however, in providing means of acquainting others with the possibilities of and techniques for using new technology in a way analogous to that which farm agents, land grant colleges, and State agricultural stations make such data available to the farmers. That is, there is a substantial role for the Federal Government in doing research and development, exploring new technologies, building demonstration plants, instructing municipalities and States in the use of these plants. But in my opinion the decision of which of the technologies to use should be left to the local authorities.

Mr. **Daddario.** As progress is made in this field, do you feel we must be careful not to disturb this relationship?

Dr. **Gershinowitz.** I would think so. I think that the progress of technology shows particularly improvements of technology come from local applications of what has been developed elsewhere, and that a continuing improvement in efficiency changes in design, modifications in the way of operation will come from the independent utilization of technology by the sources that have to make use of it.

Chairman **Miller.** Mr. Chairman.

Mr. **Daddario.** Mr. Miller.

Chairman **Miller.** I am interested in your reaction, Doctor, to this because I agree we have been through an exercise where some of the other things were explained by very competent people.

I wonder if the artificial geographic lines in which we bound our States are the things which should limit this or should they be more like the environment of a watershed that may cover two or three States. Texas is a big State. Something could take place in the panhandle—well, I will illustrate it better by saying when Dallas and Fort Worth were fighting over the building of an airport, what it was going to be called, I asked a man from Beaumont, "Now you Texans have to make a decision. You have to line up with Dallas or Fort Worth. On which side are you?"

He said, "Those people are so far north where we come from we call them damned Yankees."

California is a big State. What might be good for San Diego might not be very good for some other portion of the State.

On the other hand, Rhode Island and Massachusetts, and Mr. Daddario's Connecticut are relatively close.

Can we lay down any fixed rule in this field saying we are going to let the States do part of it and let somebody else do the other part? We are falling into a trap when we do that.

Dr. **Gershinowitz.** I hope I am not falling into a trap, Mr. Miller. I believe that the term I probably should have used was not simply "States," but "local regional authorities" that are concerned with the aspects of the problem. Certainly river basins and air sheds and all things of that sort have to be included.

Chairman **Miller.** I concluded that is what you really meant.

Dr. **Gershinowitz.** That is what I meant; yes, sir.

Chairman **Miller.** Rather than saying the artificial lines should be followed.

Dr. **Gershinowitz.** Yes.

Chairman **Miller.** It doen't necessarily follow those are true.

Mr. **Daddario.** I find myself intrigued by the organizational setup you suggested in working our way through this morass of problems. In fact you tie all the various pollution problems together, emphasizng, and reemphasizing for us that these cannot be separated one from the other.

And yet, I wonder about the time involved in the formation of these, and the chairman of these committees working together seeing there is no problem of antagonism.

The government is being charged already with certain responsibilities of establishing the air quality standards. How do we prevent the situation from becoming catastrophic while we are establishing this very nice organizational structure?

Dr. GERSHINOWITZ. Well, I would be the last to deny that an organizational structure can be inhibiting rather than assisting in progress. However, I think in this particular case the assignment of responsibility for short-range solutions to these engineering committees, combined with the simultaneous assigning of some responsibility to each of the chairman for making sure that he is looking over the shoulder of the others around, is already some assurance that rash things would not be done but also that more important things will be done quickly without waiting for a complex interaction of committees. I think the mere realization that there is such a structure, that there are channels available to these specialized specific committees, to obtain the kind of advice and information that interacts with them, is enough in itself to take care of the lack of interaction. It provides for immediate support, immediate application of knowledge. At the same time it provides for fairly immediate application of knowledge from interacting disciplines.

I don't think it is necessary, as I conceive it, for each of these committees to delay any recommendation until everyone else has had a chance to look at it. I think that is not the way they are intended to work. It is just as long as they are conscious they have that broader responsibility, they will almost automatically start to incorporate that way of thinking into their recommendations.

Chairman MILLER. Doctor, have you ever taken a look at the National Council on Marine Resources and Engineering Development, or the work that is being done in the Space Council? I, as a member of the Merchant Marine and Fisheries Committee, 8 or 9 years ago was made the first Chairman of the Committee on Oceanography after the Academy of Science rendered its report.

There had never been a complete study of this kind within Government. The first thing we found was that oceanography was centered primarily in seven agencies of Government. Although there had been an interagency committee, it was on the third or fourth echelon and everyone would have to go home or work their way up to the Secretary and on down. Nothing was done, so much so that there was no one place in Government you could go and find out what was being done in this field. There was duplication.

Well, one of the first things we did was to set up the calibration center. We tried it by law and it got bogged down but fortunately, a very fine Under Secretary of the Navy succeeded in getting an authorization through under the general powers of the President.

We found that there was no standard for instrumentation in the field of oceanography, even in the private sector. Woods Hole wanted to do something; they wanted to do something else at La Joya, Tex. Many were getting into this field because of exploration. So we established the calibration center so that we could standardize.

Now we have an agency headed by the Vice President and staffed by a competent man who can direct its activities.

If it wasn't for the National Space Council, because space program was scattered in numerous agencies; I don't think our space program would be where it is.

Now, do you think that if we had some sort of environmental agency comparable to this council that we could make more progress than we could in trying to reorganize the Government? Because every chairman feels this is giving up of authority, when you know it might be good to do so. You don't like to establish a precedent.

Have you looked at this or has the Academy of Engineering looked at it?

Dr. GERSHINOWITZ. Yes, Mr. Miller, I think those are very important and valuable precedents and examples we can use in dealing with the environments.

Chairman MILLER. I think this can be a new form that we can take to get solutions for some of these distinct problems. I am inclined to think sometimes local government can handle them. I live in the San Francisco Bay area that is governed by one of the first very successful air pollution boards. Mr. Linsky is responsible for it. I had the privilege of going over to the University of West Virginia at his invitation the other day. In our own city, Alameda, we disposed of the waste by dumping it into the bay or burned it down at the bay. They used to do this at Berkeley.

The board put a stop to burning, even the burning on these dumps. This just raised the dickens. The city fathers said, "We have about 5 more years. What are we going to do when that is gone?" They are still worried.

Then they brought in a counterproposal. The mayor said, "What are you doing? You are stopping burning; this smoke isn't going to hurt you, but the rats will." I tell you the housewives and people concerned with burning were ready to turn turtle when they pictured rats running all over the place. We controlled the rats, and the burning. I don't know what we are going to do with it. There is not much more of the bay we can fill in. I realize the importance of this.

I wonder, in view of some of these things that have taken place, if you can depend too much upon local authorities. Left to local authorities, the instance I cited in my own hometown, we would still be filling and burning. But they consented to an environment group coming into the bay area that could override them. Thank goodness we are not burning anything.

Dr. GERSHINOWITZ. I said, Mr. Miller, that the responsibility for criteria and standards are definitely those of the Federal Government, rather than local authorities.

Chairman MILLER. I don't know, it might be Federal, but I do think you have to have some sort of a regional part.

Dr. GERSHINOWITZ. Regional, certainly.

Chairman MILLER. I could cite cases where one small political subdivision blocked stream control; it would have been much more economical on a watershed basis. You get into these little jealousies.

Mr. DADDARIO. I don't see any particular conflict, Dr. Gershinowitz, with what you said and what the chairman is talking about. I quite agree with him that unless it is done in the right way it will stifle progress. You would take advantage of various alternatives to accomplish what ought to be accomplished, and if it was spelled out in the right way, public opinion would demand it be done.

Dr. **Gershinowitz.** Yes; exactly.

Mr. **Daddario.** Did I hear you say that we ought to take this matter of establishing criteria and put it into the National Bureau of Standards.

Dr. **Gershinowitz.** No. I said—I better read what I said just to make it sure. I would like to read, or requote my statement, which involves the National Bureau of Standards.

> The factual data on which the standards and criteria should be fixed should be developed by an institution or agency which does not have a responsibility for policymaking or enforcement of a particular aspect of the pollution-resources question. An agency that has served a similar function is the Bureau of Standards.

Chairman **Miller.** We will buy that.

Mr. **Daddario.** You are not saying the Bureau of Standards. What you are doing is offering an opportunity for a solution by having one central agency which could, in fact, establish these standards.

Dr. **Gershinowitz.** Yes.

Mr. **Daddario.** Dr. Gershinowitz, we have reached the time when we have to bring this meeting to a close.

I appreciate your testimony and the work which you have done in the National Academy of Engineering. You have been a great help to this committee.

Dr. **Gershinowitz.** Thank you, Mr. Daddario. I assure you we consider it not only our responsibility but our pleasure to continue to work with you and your committee.

Mr. **Daddario.** Thank you ever so much.

Chairman **Miller.** I would like to join the chairman of the subcommittee in that comment, Doctor.

Mr. **Daddario.** This committee will adjourn until tomorrow morning at 10 o'clock at this same place.

(Whereupon, at 12:45 p.m., the subcommittee adjourned until 10 a.m., Thursday, March 14, 1968.)

ENVIRONMENTAL QUALITY

THURSDAY, MARCH 14, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:08 a.m., in room 2325, Rayburn House Office Building, the Honorable Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. Daddario. This meeting will come to order.

Our first witnesses today are colleagues who have introduced bills concerning a Council on Environmental Quality and a Council of Ecological Advisers.

These concepts are very interesting to me, and I am pleased to see the thoughtful work which has gone into their preparation.

I would point out the train of thought which is contained in these recommendations coincides somewhat with suggestion of a technology assessment board as indicated in H.R. 6698.

We have had considerable discussion of all kinds here of a superagency management coordination function, and I frankly have not reached any firm conclusions as to the exact form of structure which would best meet the problem. Therefore, I am pleased to have the opportunity to hear from my colleagues who have given a great deal of time and attention to this.

Congressman John D. Dingell, of Michigan, has been an ardent champion of the environment for many years. The viewpoints which he has brought to conservation policy have been enlightening and persuasive. Therefore, it is no surprise to me to see his great interest in this particular field.

Congressman Dingell is also an old friend who has appeared before this committee before. We have always found his testimony to be of great interest and of great help to us in our deliberations.

Mr. Dingell, we will be very happy to hear from you at this moment and recognize that you are in a rush to go off somewhere else.

(The text of H.R. 7796, introduced by Mr. Dingell, and H.R. 13211, introduced by Mr. Tunney, follows. H.R. 14605, introduced by Mr. Matsunaga, and H.R. 14627, introduced by Mr. Corman, are identical to H.R. 13211.)

[H.R. 7796, 90th Cong., first sess.]

A BILL To establish a Council on Environmental Quality, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, **That this Act may be cited as the "Environmental Quality Act of 1967".**

SEC. 2. The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, both living and nonliving, and the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, urban and rural planners, industry, labor, agriculture, science, and conservation organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

SEC. 3. The President shall transmit to the Congress annually beginning June 30, 1968, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, man-made, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban, and rural environment; and (2) current and foreseeable trends in management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation.

SEC. 4. (a) There is created in the Executive Office of the President a Council on Environmental Quality (hereafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President, by and with the advice and consent of the Senate, each of whom shall be a person who, as a result of his training, experience, and attainments, is exceptionally qualified to analyze and interpret environmental information of all kinds, to appraise programs and activities of the Government in the light of the policy set forth in section 2 of this Act, and to formulate and recommend national policy to promote the improvement of our environmental quality.

(b) The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).

(c) It shall be the duty and function of the Council—

(1) to assist and advise the President in the preparation of the Environment Quality Report;

(2) to gather timely and authoritative information concerning the conditions and trends in environmental qualities both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in section 2 of this Act, and to compile and submit to the President studies relating to such conditions and trends;

(3) to appraise the various programs and activities of the Federal Government in the light of the policy set forth in section 2 of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;

(4) to develop and recommend to the President national policies to foster and promote the improvement of environmental quality to meet social, economic, and other requirements of the Nation; and

(5) to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

(d) The Council shall make an annual report to the President in May each year.

(e) In exercising its powers, functions, and duties under this Act—

(1) the Council shall consult with such representatives of science, industry, agriculture, labor, conservation, organizations, State and local governments, and other groups, as it deems advisable;

(2) the Council shall, to the fullest extent possible, utilize the services, facilities, and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided.

[H.R. 13211, 90th Cong., first sess.]

A BILL To create in the Executive Office of the President a Council of Ecological Advisers

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Ecological Advisers Act of 1967".

SEC. 2. (a) There is created in the Executive Office of the President a Council of Ecological Advisers (hereafter in this Act referred to as the "Council"). The Council shall be composed of nine members who shall be appointed by the President, by and with the advice and consent of the Senate, and shall include representatives of science, industry, and major areas of ecological and environmental concern. The President shall designate one of the members of the Council as chairman and one as vice chairman, who shall act as chairman in the absence of the chairman.

(b) The Council shall study the national environment and the national ecology, including the atmospheric, aquatic, and terrestrial environment, relating each area of study to the health, social, and economic needs of the United States. The Council shall—

(1) report regularly to the President on the state and condition of our national environment, and report yearly on its activities;

(2) advise and assist the President on the formulation of national policy to protect, preserve, and improve our national environment;

(3) seek long-range solutions to environmental and ecological problems created by both man and nature;

(4) gather information concerning the conditions of the environment, drawing as much as possible on existing sources, and make such information available to all organizations and individuals, both public and private;

(5) coordinate research between and among public and private agencies, organizations, and individuals for the purpose of promoting advances in research and eliminating, to the extent desirable, duplication of efforts; and

(6) promote cooperation between public and private agencies, organizations, and individuals at all levels of government in the area of ecological and environmental protection, preservation, improvement, control, and research.

(c) The Council shall give priority to the following areas: air pollution, water pollution, solid wastes, atmospheric radiation, and environmental noise (especially problems associated with sonic booms). One year from the date of the enactment of this Act, the Council shall, with respect to the areas of priority, submit to the President—

(1) an appraisal of all policies and programs effected wholly or partially by Federal funds;

(2) recommendations for continued Federal support to existing policies and programs; and

(3) proposals for any new policies or programs deemed necessary by the Council for the promotion of the health, social, and economic needs of the United States as such needs relate to ecological and environmental conditions.

SEC. 3. (a) (1) Each member of the Council except the Chairman appointed from private life is entitled to $100 per diem when engaged in the actual performance of the duties of the Council, including travel time.

(2) Members of the Council who are officers or employees of the United States are not entitled to additional pay for their service as members of the Council.

(b) Each member of the Council may be allowed travel expenses, including a per diem allowance, in accordance with section 5703 (b) of title 5, United States Code, when engaged in the performance of services for the Council.

(c) Section 5313 of title 5 of the United States Code is amended by adding at the end thereof the following new paragraph:

"(20) Chairman, Council of Ecological Advisers."

(d) The Council shall appoint, without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, such personnel as it deems advisable, and prescribe their basic pay without regard to the provisions of chapter 51 and subchapter III of chapter 53 of such title, relating to classification and General Schedule pay rates, at rates not in excess of the maximum rate of the General Schedule in section 5332 of such title.

(e) The Council may procure the temporary or intermittent services of experts or consultants or an organization thereof, including stenographic reporting services, in accordance with section 3109 of title 5, United States Code, but without regard to the last sentence thereof.

STATEMENT OF HON. JOHN D. DINGELL, MEMBER OF CONGRESS FROM MICHIGAN

Mr. DINGELL. Mr. Chairman, I want to express my particular appreciation to you for the privilege of being before this committee. I also wish to express to you my sincere thanks for the privilege of working with you on legislation in the area of preservation of our environment.

I wish to express apologies to the committee, in that I am forced by circumstances, including the fact that several Members of Congress are waiting for me elsewhere, to perhaps abbreviate somewhat my testimony before this distinguished body this morning.

I would like to commend the committee. My valued friend, the distinguished and able chairman, the gentleman from Connecticut, for his interest in this. This is, I think, something that is very much in the frontiers of the law and the wise use of natural resources.

It is something where a man has, as of this time, not really placed his foot down for the first time.

I think that the wisdom of the Chair and the members of the committee in inquiring into this problem, of the wise use of environment, is something for which Americans in many generations to come will have cause to be deeply grateful and express a very real and lasting gratitude to the Chair and to the members of the committee.

For the record, Mr. Chairman, my name is John D. Dingell. I am a Member of Congress from the 16th Congressional District. If I may, Mr. Chairman, I would like to simply insert my statement in the record, perhaps summarizing very briefly.

Mr. DADDARIO. You may proceed in that way, Mr. Dingell. We will put in the record your full statement.

Mr. DINGELL. I have submitted to the committee, Mr. Chairman, a statement and a very brief analysis of H.R. 7796, of which I am the author.

For a number of years, Mr. Chairman, I have been much concerned about the problems of our environment, what mankind is doing to it.

It is my experience that man little knows the effects of what he is doing, where he does he oftentimes desregards those effects which almost invariably are destructive and with great frequency, in fact almost complete regularity, highly destructive—either for mankind or his future interests in this earth and on this world of ours.

It is my experience, Mr. Chairman, that we have found no way of putting together a real understanding of what we are doing, and we have no agency that is chargeable solely with responsibility for continuing scrutiny of what we are doing.

We lack knowledge; we lack organization; we lack the ability to establish a lasting policy and to appropriately evaluate the effects of what we do. There is very little that man does with his enormous technological capability that does not have a tremendous impact upon the environment, much of which is either unforeseen or unforeseeable under the present state of affairs. It is fair also to say, Mr. Chairman, that the handling of environmental problems is totally disorganized within the government. For years I was chairman of the Subcommittee on Oceanography, and it was our subcommittee's purpose to try and bring some order out of the oceanographic endeavors of this country. It was my experience during this time that first of all, the establishment of an institution in the form of a department within the Federal Government was not a resolution to the problem. That it would simply set up additional competition and additional duplication. It would not arrive at any organization in that area. It would not enable the bringing of more real order out of the rather chaotic circumstances that happen to exist in the field of oceanography. I believe the same general principles apply to the matter before this committee, and would urge that the device that was finally utilized by the Congress after a number of drafts be utilized here. I urge an organism which would generally be responsible for the handling of ecological or environmental problems in a wise and orderly fashion by coordinating departmental efforts.

It was my experience that the establishment of a new department would accomplish very little except to multiply the competitions that happen to exist.

I believe a worthwhile and meaningful device exists for the establishment of order out of the rather chaotic use of our environment that happens to exist today.

Perhaps the best model for this is the Council of Economic Advisers who have for years engaged in trying to establish some order out of the rather chaotic and laissez faire economic system that this country had had for many years. The remarkable success of that agency is pretty well known by all persons, whether they be conservatives or liberals in the field of economics.

And the success of this country in establishing a remarkable pattern of growth and an extraordinary pattern of economic stability is in large part traceable to the Council of Economic Advisers established under the Full Employment Act of 1946.

It is my belief, Mr. Chairman, that if something similar were done, using this as a model in the field of environmental use, we might well look forward to something similar happening in the field of environmental sciences.

I have had a number of contacts and a great deal of correspondence with the ecologists and others in this area and they have uniformly and warmly endorsed and accepted the idea that something of this sort should be done.

I could not offer you any assurances over the short haul that great things could be acomplished, but I believe that the experiences that we have had with similar problems, referring now again to the Council of Economic Advisers, and of course to the efforts that we have finally successfully achieved to order our environmental research in the field of oceanography, that I can offer you rather firm expectation that over the long period the knowledge that is necessary for man to live in harmony with his environment and to understand the changes he is making, how these changes may be modified and controlled, so that he may look forward to long term availability of resources, will flow from the establishment of a council on environmental quality, or perhaps council of ecological advisers, as it has been called. This idea goes back to some discussions I had with the task force established by Secretary Gardner, when they appeared in the city of Detroit about 3 years ago. At that time I pointed out the chaos that exists. Favorable recommendations in this direction did flow from the Secretary's task force.

This is the history, Mr. Chairman, of the matter. I would suggest to the Chair that since this is essentially an embryonic concept, and since there is a great deal that we do not know, we should utilize to the fullest degree possible the principle of allowing this agency the maximum of freedom that we can afford it. In its early days we should afford it perhaps only the most limited kind of staff that is necessary to carry out its responsibilities.

The Council of Economic Advisers exists with a very limited staff, and does provide great work. I believe starting slow and small in this way would provide the basis for whatever growth is necessary in future times as the knowledge becomes more comprehensive and as the organism has gained experience and ability, and has begun to establish a meaningful program for establishing the order that is necessary in our use of the environment.

With those remarks, Mr. Chairman, I wish again to commend you, and members of the committee, for your scrutiny into this very important matter. It is my hope that something of this kind will come about at an early time because we are frankly playing Russian roulette with our future, and with our environment. There is strong reason to think unless something very drastic is done in this country the pollution of or air, soil, atmosphere, waters, may conceivably mark the beginning of the extinction of mankind.

Certainly, the possibilities of change in the oxygen balance in the air, the exhaustion of the oxygen supply, change in the nitrogen balance, exceeding the capacity of photosynthesis to replace oxygen in the air, or perhaps the excessive pollution of the oceans, may now be taking place, may be marking at this time, without our knowledge, the beginning of the extinction of mankind.

I think the only way we can ever really come to an orderly understanding of these matters so that we can head them off calmly in time that future generations won't blame us for our stewardship of our resources is to establish a device of the kind I have indicated, a council of environmental quality or ecologist advisers.

Mr. DADDARIO. The gentleman from Michigan is to be complimented for the advice he has given us this morning, and the strong feeling not only about his own bills but the whole matter of the environment.

I would like to ask him just one question if he has the time.

Mr. DINGELL. Certainly.

Mr. DADDARIO. You have referred to the Council of Economic Advisers as a model of the structure which you contemplate in the legislation you are proposing.

I wonder how you correlate this with the Federal Council for Science and Technology and its Committee on Environmental Quality, under the control of Dr. Hornig, which provides within the executive branch some structure within which environmental activities would be controlled and could be developed, including as I understand it, a recommendation that an annual report be made.

Mr. **Dingell**. I must confess to you, Mr. Chairman, I am a little troubled about exactly where the organism is placed or what it be called.

My experience with the Office of the Science Advisers to the President has been that almost without exception that the individual who holds that office and the staff with whom he works are outstanding men. They are, however, it is my feeling, rather timorous in that they lack both the strong concern over these problems, manifested in public statements, that would necessarily flow from an organism like the council of ecological advisers or council on environmental quality.

It is my feeling that they also lack sufficient dignity in the scheme of things to really have the kind of impact that is necessary in the light of the magnitude of the problem as we know it exists. Now we don't know exactly what the problem is and we don't know exactly what the effects of the abuse of our environment are. But we know they can be disastrous, and we have enough evidence to indicate that the time of disaster may be nearer at hand than most realize. I happen to think that the institution you mentioned is not going to be sufficient under the long-term needs of the country.

I have the feeling that the only way we can get sufficient attention focused on environmental problems is to set up as H.R. 7796 would, and other bills would, independent organisms within Government, not directly under the thumb of the President. And I think the Science Adviser has the defect he is too much under the President's thumb. The agency to which I refer must be made up of men who are renowned in prestige in their fields, made up of men of ability, experience, high attainments, exceptionally qualified as the bill would provide—to carry forward their responsibilities is the way to handle this. It must be independent to be effective.

I think the Science Adviser is a fine step, and I think an office under him is certainly a step forward, but I think it lacks the prestige, I think it lacks the ability, I think it lacks the dignity, I think it lacks the prestige that is necessary to make the kind of progress that is going to have to be made in just the new few years to preserve mankind in this country and on this earth. With the technological demands we are making on our resources, the waste problems that we have, and the other problems like pesticides which are very, very troublesome in the long pull we must have the effectiveness which comes of independence.

Mr. **Daddario**. John, thank you ever so much.

Mr. **Dingell**. I again wish to commend you. I am delighted to see that somebody with authority to do something within this body, and with the committee responsibility appropriate for the consideration of legislation is working on this problem. I do hope, Mr. Chairman, in early time some kind of legislation—I don't advocate it necessarily be mine or any other Member's, but just some kind of legislation comes forth from this committee because I think this is one of the major problems this country is going to face in the years to come. I am grateful to see you are doing it.

Mr. **Daddario**. Thank you.

Mr. **Dingell**. Thank you, Mr. Chairman.

(The prepared statement of Hon. John D. Dingell is as follows:)

PREPARED STATEMENT OF HON. JOHN D. DINGELL, MEMBER OF CONGRESS FROM MICHIGAN

Mr. Chairman and Members of the Subcommittee, for the record, my name is John D. Dingell; I am a Member of Congress from the Sixteenth District of Michigan. I wish to thank the Chair and Subcommittee for giving me this opportunity to testify in behalf of my bill, H.R. 7796.

Mr. Chairman, mankind is playing an extremely dangerous game with his environment. Unless we change our ways, mankind faces the very real possibility of extinction from misuse of environment.

For centuries, man has exploited and freely used the resources provided by his natural environment, unhampered by restrictions, secure in his belief that nature's bounty would last forever, heedless of any consequences in his headlong rush toward greater power and prosperity.

For the last two hundred years, Western man's attitude toward his environment has been characterized by an emphasis on economic motives. The industrial revolution which has provided us with the gift of technology also inaugurated specialization and division of labor as prerequisites for production for profit. Technology could be used profitably if production were specialized; indeed, the profit margin often depended on the technological capability of an enterprise. In turn, this idea produced improved technology with even greater capabilities. Our Nation's wealth was founded on technological progress spurred on by the profit motive.

However, this single-minded attention to production for profit resulted in severe social problems. Dislocation of the labor force, a highly mobile society, rapidly changing manpower needs, were some of them. More importantly, specialized production technology took no heed of the wastes created by it. A producer, intent on manufacturing a better mousetrap did not, in those days, need to concern himself with the pollutants and wastes his plant dumped indiscriminately into the air, the water, the surrounding countryside. This was someone else's problem. He did not need to concern himself with the noise his factory made, or the clogged roads caused by his delivery trucks. A coal mine operator did not worry about the scarred landscape left after a mine was abandoned, the severe erosion caused by rain water coursing down hills stripped of vegetation so access roads and auxiliary service plants for a mine could be installed and the mine operated at its full technological capability.

It is the force of these now accumulated changes, of unrestricted and uncoordinated manipulation and neglect inherited from past generations which is haunting us today. Not too long ago, Admiral Hyman Rickover stated:

"In the brief span of time—a century or so—that we have had a science-based wasted irreplaceable fuels and minerals and perpetrated incalculable and technology, what use have we made of it? We have multiplied inordinately, irreversible ecological damage. On the strength of our knowledge of nature, we have set ourselves above nature. We presume to change the natural environment for all the living creatures on this earth."

It is simple enough to detect the deterioration in our present natural environment. Air and water pollution, rising mountains of solid wastes being disposed of by antiquated methods, roads and highways choked by rapidly increasing numbers of automobiles, decayed neighborhoods, rising decibels of noise, disappearing open spaces, all represent a backdrop for American life in the second half of the 20th century. John Kenneth Galbraith provided us with a thumbnail sketch of this situation in his "Affluent Society":

"The family which takes its mauve and cerise, air-conditioned, power-steered, and power-braked automobile out for a tour passes through cities that are badly paved, made hideous by litter, blighted buildings, billboards, and posts for wires that should long since since have been put underground * * * they picnic on exquisitely packaged foods from a portable icebox by a polluted stream and go on to spend the night at a park which is a menace to the public health and morals. Just before dozing off on an air mattress, beneath a nylon tent, amid the stench of decaying refuse, they may reflect vaguely on the curious unevenness of their blessings. Is this, indeed, the American genius?"

Our natural environment must maintain a constant, delicate balance. If any of its components are jarred by a pollutant, by the overenthusiastic use of a pesticide, by overcrowding, the dire effects will be many and varied on the whole environment. Our knowledge of the nature and extent of some of these effects is inadequate. We have been warned by scientists, citizens' organizations, public officials and government agencies of the dangers and consequences of such upsetting agents as air pollution, water pollution, excessive noise, urban blight, the population explosion. We do react to crises in our environment but we anticipate and avoid them only occasionally and haphazardly. Public awareness and interest in a problem is allowed to lag as soon as its critical stage has passed. We have not yet learned that we must consider the natural environment as a whole and assess its quality continuously if we really wish to make strides in improving and preserving it. In his recent message to the Congress on conservation. President Johnson said:

"Technology is not something which happens once and then stands still. It grows and develops at an electric pace. And our efforts to keep it in harmony with human values must be intensified and accelerated. Indeed, technology itself is the tool with which these new environmental problems can be conquered."

There have been many thoughtful proposals made on how to deal with the problem of our rapidly deteriorating environment. They have come from the scientific community, from government agencies, from private groups reflecting the varied concerns of their members. There have been suggestions ranging from the establishment of select Congressional subcommittees to the use of nongovernmental "environmental think tanks" or "resources intelligence agencies" to avoid any bias.

H.R. 7796, which I introduced on March 23, 1967, expresses my conviction that we need the vigorous involvement in this problem on the part of the Executive Office of the President of the United States. The underwriting of a national strategy for overall, long-term environmental management would guarantee continued public interest and willingness for long term planning. I propose that the President begin to submit to the Congress an annual report of the status of our natural resources coupled with an assessment of the current and anticipated trends of their utilization and the effects of such utilization on public health and welfare.

Such an assessment would make it possible for us to eliminate potential abuses at the source rather than having to undertake the costly and time consuming effort to control and abate an environmental insult after it has occurred. To issue a meaningful and accurate report, a great deal of information and knowledge must be gathered, beginning with an understanding of fundamental environmental and ecological factors which must be controlled in order to achieve and maintain a desirable and attainable environmental quality. We must develop a systematic approach toward maintaining a healthy and livable environment as a whole and abandon the idea of focusing our efforts on specific, isolated forms of environmental contamination.

To aid the President in accomplishing this task, I propose to create in the Executive Office of the President a Council on Environmental Quality composed of three members who, as a result of their education and training coupled with experience and personal accomplishments, would be exceptionally qualified to analyze and interpret environmental information, and assess remedial programs and activities in terms of immediate and long-range planning goals.

The Council would thus be the focal point for all new and authoritative data concerning the status and trends in environmental quality. It would interpret these data, analyze their usefulness and importance, and inform the President of their impact on the national ecology as a whole. Based on its findings, the Council would then make appropriate recommendations for Federal action designed to foster and improve environmental quality "to meet social, economic, and other requirements of the Nation."

I agree with those who maintain that Federal action alone is inadequate. I firmly believe that coordination and close contact must be maintained at all times with State and local agencies, industry, urban planners, agriculture, conservation groups, and the scientific community. I therefore recommend that the Council consult regularly with all these groups and make the fullest use of their services, facilities and information of all kinds. We need sustained, wholehearted public support for a program of this magnitude. and there is no better way of than to enlist the help and active understanding of every qualified individual.

There may not always be agreement on a good policy to follow. But there would at least be a concensus of what is bad in our environment. This, too, would give us a basis on which to select an effective remedial program.

Numerous agencies and departments are now engaged in extensive research, surveys, data collection and evaluations of ecological phenomena and the results of man-made manipulations of his natural environment. However, the Council would provide a top level, independent body, unencumbered by the demands and politics of operating programs and individual interests, free to draw independent conclusion and to formulate a broad policy which would be of nationwide benefit.

I am pleased that this Subcommittee is continuing its inquiry into the status and condition of our natural environment. My bill, a brief analysis of which is submitted for the record, was referred by the Committee on Interior and Insular Affairs to the Committee on Science and Astronautics on April 17, 1967. It is my sincere hope that it will be acted on favorably by the Committee.

We know that man, as the dominant species, is the focal point of his environment. Man has created the environmental problems which confront him today; he must now move swiftly to remedy them in order that the environment may continue to meet his needs rather than destory him. We can no longer subordinate environment to our technology; rather, technology must become a servant to our natural environment, shaped and adapted to the conditions we want to live in. Enactment of H.R. 7796, the proposed Environmental Quality Act, can effectively aid us in a nationwide effort to consider the consequences of our actions and take a rational approach toward improving and maintaining the chosen quality of our environment.

Mr. Daddario. Our next witness is the Congressman from Hawaii, Mr. Spark M. Matsunaga, who has introduced a bill, H.R. 14605.

We are pleased, Mr. Matsunaga, to have you here this morning. We are anxious to listen to your advice and recognizing that you have a statement, you can proceed in any way you like.

STATEMENT OF HON. SPARK M. MATSUNAGA, MEMBER OF CONGRESS FROM HAWAII

Mr. Matsunaga. Thank you, Mr. Chairman and members of the subcommittee.

Since the statement is very short, Mr. Chairman, I will read it for the purpose of conserving time.

Mr. Chairman and members of the subcommittee, I thank you for this opportunity of appearing before you and expressing my views with respect to H.R. 14605, a bill to create in the Executive Offices of the President a Council of Ecological Advisers.

This is an identical bill introduced by my colleague from California, Mr. Tunney.

The distinguished Secretary of the Interior, Mr. Stewart L. Udall, a former Congressman from Arizona, has summed up our traditional attitudes toward our environment in these words:

> We have accepted noise, foul air, (and) dirty rivers as inevitable consequences of industrialization . . . But now we are changing our basic assumptions. We have been a filthy generation. What will become of our grandchildren if we don't change our approach?

Secretary Udall's concern is shared by men of science who have voiced their opinions with increasing frequency in recent months. There is a sense of urgency in the scientific world that meaningful studies ought to be undertaken—and soon—in the field of ecology, the branch of science which deals with the relationship of living organisms to their environment, including man and his surroundings.

An understanding of the need that H.R. 14605 and similar bills would fulfill may be gained by a closer look at the study of ecology itself and what it involves. The basic unit in ecological studies is the ecosystem, which is the total complex of plants, animals, terrain, climate, etc. For example, a forest area may be studied as an ecosystem. Such a study would include the interrelationships between the trees, the smaller plants and animals living in the forest, and nonliving factors such as climate and soil conditions.

In a broader view, nations, continents, or even the entire planet, may be considered to be a large and complex ecosystem in which man and his activities play an important role. On a planetary scale, there are a number of disturbing theories concerning the effects of man's activities on the ecology of the earth. For example, there are theories that large-scale emission of carbon dioxide is warming the climate, or, conversely, that the emission of exhaust gases from jet airplanes into the upper atmosphere is cooling the climate. It has even been suggested that various human activities, notably the poisoning of marine plant life by water pollution, may result in the depletion of the world's oxygen supply. None of these theories has been proven to be either true or false, but the mere fact that these possibilities exist serves to underline our ignorance in the field of ecology and our need for more knowledge and more study in this relatively neglected science.

It is to the well-earned credit of the Congress of the United States that legislation has recently been enacted and other legislation is presently under consideration to halt or curb the ever growing contamination of our air, water and soil. In the consideration of such legislative measures, however, I am sure that members of Congress, with possibly a few exceptions, would be the first to admit their lack of scientific knowledge and background to delve into these environmental problems in depth and to determine the nature and effect of the interrelationships which the science of ecology encompasses.

For the reasons I have stated, and in order to provide a continuing link with the future, the establishment of a Council of Ecological Advisers is a necessary complement of the legislative effort to improve man's status in relation to his total environment. Under the terms of H.R. 14605 and similar bills, the Council of Ecological Advisers would study the national environment and ecology, giving advice and assistance to the President on the formulation of national policy to protect, preserve, and improve our national environment. The Council would conduct an appraisal of the various Federal programs dealing with the environment and would direct the coordination of these programs. First priority will be given to five key problem areas: air pollution, water pollution, solid wastes, atmospheric radiation, and environmental noise (especially sonic boom problems). However, the Council would not be limited to these areas and would be expected to study other ecological problems as they arise.

The Council would be made up of nine members, to be appointed by the President with the advice and consent of the Senate, and would include representatives of science, industry, and major areas of ecological and environmental concern.

Mr. Chairman and members of the subcommittee, I urge your favorable consideration of H.R. 14605.

Thank you very much.

In closing, Mr. Chairman, I, too, wish to join my colleagues who preceded me in congratulaitng the chairman for bringing this matter to an early hearing.

Mr. Daddario. Mr. Matsunaga, you make before this committee a very persuasive argument for the need to do something in this area. I am particularly pleased by the kind of approach you have taken and the language which you have used in your remarks, because it shows an increasing development in the Congress of an awareness and an ability to handle this kind of a problem.

I think as we in the subcommittee see it and others see this, too, there is developing within the community generally a confidence in our ability to handle matters of this problem.

We had some ecologists in here the other day headed by Dr. Lamont Cole, from Cornell University. He touched on this subject and many others. He was quite confident about the programs in being and those proposed.

These, as we examined them, were programs which depend a great deal on the international biological program. The international biological program on the other hand depends on the support we are going to be able to give it in the Congress. If, in fact, this is not funded, these programs, upon which they are so much dependent, will not be brought about. A great deal we do not know will then not be learned so that we can legislate with knowledge on the subject.

This committee will be making some recommendations about the international biological program. I do think it is going to be important for all of us to see that this gets support, because unless it does we will not have developed the knowledge necessary, not only in this country, but in this whole hemisphere.

I bring this up because I do think that our concern will show itself unless we do have a successful international biological program from the standpoint of U. S. involvement.

Mr. MATSUNAGA. I appreciate the chairman's mentioning of the international biological project because it is my information that a study is expected to be made of Hawaii and the waters surrounding Hawaii—a study which is primarily based upon the fact that Hawaii is an isolated community, thousands of miles away from the mainland of the United States, as well as from the Asian mainland. It is hoped that the study will be made soon enough, before industrialization will catch up so much in Hawaii that it will have ruined the basic ingredients of the study before the study is made.

I join with the chairman in the hope that the international biological project will be given full support by all countries involved.

Mr. DADDARIO. How does the Committee on Environmental Quality fit into the scheme of things? This is the same question I asked Congressman Dingell.

Mr. MATSUNAGA. The Committee on Environmental Quality no doubt serves a very laudable purpose within its own sphere of work. However, I see the proposed Council as a preemptive coordinating body. As was expressed by Mr. Dingell, the Council would provide the impact necessary to emphasize the urgency of the problems which now face us. I think this can come about only by the establishment of an independent agency, such as that suggested by the bills now before the committee.

Mr. DADDARIO. Are there any questions?

Mr. LUKENS. No questions.

Mr. DADDARIO. Thank you ever so much.

Mr. MATSUNAGA. Thank you very much.

Mr. DADDARIO. Our next witness is the Congressman from California, Mr. John V. Tunney.

John, we welcome you here. As the chairman of the subcommittee, I have a particular fondness for the gentleman from California, because his early and formative years, which we believe have added to his capabilities and strength, took place in Connecticut.

We look to him as the supporting Congressman from Clearfield County which he knows so well, and which knows him so well. I have found over the course of time that we in Connecticut, as well as the people in California, have every reason to be proud of the gentleman.

I am especially pleased he has taken such great interest, as Mr. Dingell and Mr. Matsunaga have, in the problems of our environment. It shows a growing tendency on the part of the Congress to be concerned not only with the impact of pollution on our environment, but with an overall problem. We cannot separate water, soil, and air pollution, one from the other as we have.

Mr. Tunney, in his statement and in his private conversations with me, has been particularly concerned about the way these things are managed—how do we, in fact, put together the structure of these things and apply our best talents and resources to come to a solution about these problems before they become disastrous.

Mr. Tunney, we are happy to have you here and happy to hear you.

STATEMENT OF HON. JOHN V. TUNNEY, MEMBER OF CONGRESS FROM CALIFORNIA

Mr. TUNNEY. Thank you, Mr. Chairman. I can't tell you what a great pleasure it is for me to appear before your committee because perhaps more than any other man in Government you have shown leadership that I think is going to be needed to bring about a resolution of our environmental problems, and the one sad note that I have about my residence in Connecticut is that I didn't come from a district where I could have voted for you because you were in Congress while I was still in Connecticut, and unfortunately I came from a different county. But I want you to know that the nutmeg as a part of my early life certainly has helped me take care of the citrus farmers out in California. You are very gracious to allow me to make a few remarks today about H.R. 13211, my bill to create a Council of Ecological Advisers.

I would like to say that my statement is rather long, and if it could be made a part of the record I would like to just make a few excerpted remarks from my statement.

Mr. DADDARIO. Without objection it will be entered into the record.

Mr. TUNNEY. I feel perhaps Congressman Dingell also should be mentioned as a great leader in this effort. His bill which was introduced before mine certainly is the pilot light which inspired me and my bill is but a refinement, in my opinion, of his legislation, and he certainly is to be complimented for his imagination and initiative in this area.

I feel that whether we have a council of environmental advisers or a council with ecological advisers makes no difference, but what we do need is a council at the Presidential level coordinating all the programs that the Federal Government has to handle the pollution of our environment.

I feel that a council of ecological advisers would be helpful in establishing in the Office of the Presidency, a basic policy objective. It would have the advantage of being able to take an overview of all the environmental problems, whether it is radiation, air pollution, water pollution, it makes no difference. Essentially, ecology is the relationship of life to the environment around life, and our major concern of course is man, and man's relationship to his environment.

But equally important is the relationship of plant life to the environment, because we all need food, and animal life to the environment, whether they are animals that we eat, or whether they are animals in the forest that are a part of our heritage.

And so I think that we have to understand the interrelationship between life and environment and environment and life.

I think this is not being done at the present time by any governmental agency. I don't feel that we have an appreciation of the interaction of all kinds of pollution, one to the other, and to all kinds of life.

I would also like to say that it seems to me that it necessarily follows in Government that when you recognize that there is a problem, for instance, say, with water pollution, that many different departments become involved in trying to rectify the situation.

We have for instance the Department of the Interior, which has an obvious interest in trying to abate water pollution, but we also know that the Department of Commerce has an interest, because industry needs water, and it needs good quality water, and so they have an interest.

The Department of Health, Education, and Welfare has an interest. If water is polluted it is obviously going to affect the health of human beings.

And so you have a division of responsibility, and sometimes you have a duplication, and sometimes the departments are working at cross purposes one with the other. So it is for this reason that I feel it is essential that we have a council, or another body, whatever you would like to call it, which is capable of coordinating, giving a sense of direction, and advising the President as to how there can be a synthesis of the programs that we now have in the Federal Government.

I might say that I sent a copy of the legislation that I introduced to a number of leaders in environmental and ecological problems throughout the country, and I would like to include for the file their responses to me if you feel that that would be appropriate. And then I would like to excerpt from the letters a few comments which I think would be of particular interest to this committee.

(The letters referred to are shown in app. C, p. 557.)

Mr. Tunney. Dr. Frederick Sargent, chairman of the Committee on Human Ecology of the Ecological Society of America, wrote that the members of that committee, and I quote:

> * * * decided that the "Ecological Advisers Act of 1967" was sufficiently important to demand a supporting statement from the Committee as a whole.

Hughes Aircraft Co.:

> I have read with interest and approval the print of H.R. 13211 which you provided, and your speech of 27 September 1967, which introduced the measure to the Congress. I endorse the principal thrust of your proposal and will be interested to observe its progress.

W. H. Pickering, director of the Jet Propulsion Laboratory:

> The matter of environmental control with which you have concerned yourself in H.R. 13211 is unquestionably one of vital and immediate concern.

The letter continues for four pages and I strongly urge each member to read it.

Athelstan Spilhaus, president of the Franklin Institute:

> I was greatly cheered by the imaginative and comprehensive approach of H.R. 13211, the "Ecological Advisers Act of 1967."

He then spells out in some detail his ideas for solutions to the problems.

Prof. Norton Nelson, chairman of the New York University Medical Center, Institute of Environmental Medicine:

> Your proposed Council of Ecological Advisers goes directly to this point; the need is real and urgent.

Dr. James H. Steiner, medical director of Eastman Kodak Co.:

> Although it has been my privilege to give testimony on a number of occasions on proposed legislation, I cannot remember a single instance when, even though I favored the proposed bill, I did not have at least minor modifications to suggest. Consequently it is a real pleasure to tell you that I am enthusiastic about H.R. 13211, and would strongly urge its enactment, as one of the most important and constructive actions which the Congress and the President can take.

The managing director of the National Tuberculosis Association:

> It seems to us that the time is ripe for the type of National Council of Advisers your bill proposes.

Roy E. Peterson, Litton Systems, Inc.:

> I am in complete agreement with this proposed legislation since I firmly believe that a comprehensive ecological approach, one stressing cost/benefit as well as cost/effectiveness represents the only intelligent response to our total problem.

There are many other letters, Mr. Chairman, which I could read, but which I know the committee doesn't have time for me to read, that I would like to introduce into the file, because I think that they are pertinent.

It seems that there is almost unanimous support from people who do have a concern about this problem, that something should be done and should be done now.

We just can't afford to wait until our environment becomes so polluted that it changes the basic ecology of the world, of our planet, and, therefore, I am particularly pleased that you are holding these hearings, that you have such a tremendous interest in the problem, and are really popularizing this concept for the Nation.

Mr. DADDARIO. The service you have rendered, Mr. Tunney, not only in your statement but the indication of support by the letters that you have given us is important because it shows the dialog developing of an important kind. People are becoming interested.

Congressman Dingell, Matsunaga, and others in Congress are developing a relationship which is extremely important.

Dr. Sargent who wrote one of the letters to you was a witness that appeared before us.

An example of the way in which this activity is growing is the University of Wisconsin branch at Green Bay, where a center of ecology is in fact being put together.

During the course of our discussion, one of the witnesses said that he did not know of any place where this was being done. Dr. Sargent was able to show that there was one place at Green Bay, and then it came out the University of New York, at Albany, has another center being created, and which will be inaugurated in ceremonies beginning this coming Sunday.

I can recall a year or two ago when we were dealing with the subject we put out a statement which in the first line contained the word "ecology." One of the reporters who had been covering the hearings thought ecology was such a little known word that we ought to define it so that people would understand it.

In the time since we find that this is no longer a criticism. People, in fact, are beginning to associate the word with the problem, and I think this is a sign of progress.

We will certainly take into consideration what you have said, and as indicated earlier by informal remarks to me, the concern you have about managing these programs.

One of the underlying purposes for these hearings is that we can take a look at the agencies of government involved in this program and can see how they have carried out recommendations made by the Sargent committee, the Spilhaus committee, and others that have been involved, and the recommendations that this committee published as a result of our hearings on the environment a year or so ago.

We are not only looking at this in depth through these hearings, but we are having staff work done on it, and we have outside consulting advice of a highly skilled nature which will be able to give us a hand in the report, recommendations, and conclusions we reach as a result of these hearings.

So, we all, I think, are emphasizing the various aspects of this problem which need to be looked at seriously. I compliment Mr. Matsunaga, and I compliment you and Mr. Dingell and Mr. Corman, who also has submitted a statement for the record.

I am pleased to note congressional support, and pleased to have an opportunity to have heard from you.

Mr. TUNNEY. Mr. Chairman, thank you very much. Just one last point that I would like to make, and that is I think that it is very important that any council that be established include laymen, citizens, nongovernmental employees. I think that we ought to have social scientists; we ought to have city planners; we ought to have city administrators, because let's face it, anything that man does in the way of building up industry, or building up a transportation system, or whatever it is, it is going to pollute the environment to some extent. And this is a question of a trade off of values. We know that when we put chemical sprays on crops that to a sense we are going to pollute the water systems in the nearby areas. But on the other hand this is a trade off. We feel to eliminate the pests is more important for food than the minor damage that may be created by some water pollution.

So I think that we have to have citizens outside of government helping to make these value judgments of what the trade off should be, and that is why I think that we need to have a council at the Presidential level that does have these private citizens involved in making the determinations as to what the trade offs are and should be in the future.

Mr. DADDARIO. Thank you, Mr. Tunney.

(The prepared statement of Mr. John V. Tunney is as follows:)

PREPARED STATEMENT OF HON. JOHN V. TUNNEY, MEMBER OF CONGRESS FROM CALIFORNIA

America has been blessed with abundant resources. Together all of our resources comprise the basis of the environment of the wealthiest nation on earth. Until this century, our Nation was primarily occupied with the development of most of those resources—with the mining and processing of mineral deposits, the planting and harvesting of the land, the cutting and milling of timber, the transport and industrial uses of water, and the mining, drilling, processing, and combustion of fossil fuels. In the early part of the 20th century, conservation of some of the overexploited resources of our country became a national interest. The Government began to take steps against the misuse of our most precious national wealth, next to our people, the natural resources of America. Characteristically, conservation was first concerned with the most obvious blemishes resulting from earlier misuse—denuded timberland, eroded farmland, very inefficient and wasteful mining and processing operations, and eventually polluted and poisoned waterways.

In the past two decades the concern over the resources of our environment has grown immensely. Not only are we concerned with the impact and effect of that use and misuse of our resources, we are now concerned with the impact and effect of that use and misuse throughout our environment. Man and nature have altered our environment; and, in doing so, have altered the ecology of our Nation—the interrelationship, interaction of all parts of our environment. We are no longer concenred just with the misuse of mineral deposits and its impact on the land; we are also concerned with the poisoned waters resulting from poor mine drainage. We are no longer concerned just with the agricultural problems which result from the misuse that created the great midwestern Dust Bowl, we are also concerned with the effects of the dust in the atmosphere and the air breathed by millions of people in those agricultural States. We are no longer concerned just with the inefficiency and waste of poor smelting and metal processing; we are concerned with the impact of poisonous air emissions on the lungs and lives of millions of urban and rural dwellers.

We have not yet dealt with these problems effectively. We have no even considered all of the problems besetting our environment and their effect on our ecology. We have a tendency to deal with problems in a piecemeal manner. We do not anticipate a problem in a so-called preventative fashion. Rather, we let problems reach a point where we must try to cope with them in order to keep them from getting even more out of hand. This certainly has been the case in the area of environmental quality control.

The Congress, State and local governments, and industries have only recently begun to show their concern and awareness of the problems of air and water pollution in the face of the ever-increasing outcry of public dissatisfaction. We have, however, continued to act in our manner of responding to problems once they have become large enough to attract national attention. We have been caught ill prepared to deal with these problems, and the indecisiveness of our legislation is indicative of our lack of foresight. While we are presently looking at the two giants in the area of environmental quality control, air and water pollution, we are not viewing them in a sophisticated enough manner, nor are we paying enough attention to their impact on each other and on the entire environment. We are not giving enough consideration to other problems which will increase with our national growth if they continue to go on unchecked.

We have a need to look after the entire environment and the ecology of that environment. We must know the relationship of air to water pollution, and of each to solid waste matter, and of all to each other. We must understand the effects of radiation on all forms of pollution, the effects of pollution on the weather, the relationship of topography to pollution, and the beneficial combinations of urban planning to topography and the relationship of that combination to pollution abatement. We must understand the impact of environmental change on human beings, and how the changes in the quality of the atmosphere and the appearance of the environment affect man both physiologically and phychologically.

We have a need to understand our physical surroundings and the ecology of that environment better, so that we may direct our efforts at beneficially alterning our environment, and so that we may be able to foresee future problems that could be averted at an early stage. We must have an overview of our surroundings so that we can understand our strengths, weaknesses, and needs, and act accordingly.

At present we are dealing with many of the problems of our environment in many areas of the Government. I do not question that each of these areas has a special and particular interest in its area of authority. The Public Health Service, in the Department of Health, Education, and Welfare, certainly has appropriate interest in air pollution. For air pollution has direct effects on our health. However, the Department of Transportation also has an interest in air pollution as it relates to automobiles and their ability to create air pollution, and as it relates to decreased atmospheric visibility which affects air transportation. Commerce has obvious interests when one of the great sources of air pollution is industry; and Agriculture is keenly interested in the impact of polluted air on crops and vegetation. I do not deny that each of these departments has a specialized and necessary interest in air pollution.

The Department of the Interior has an important concern with water pollution, for it has jurisdiction over the billions of gallons of water which come from areas of Interior's jurisdiction. The Department of Housing and Urban Development also has an intense interest in water use, for it must concern itself with the water needs, and water and sewage systems of the great cities. Agricultural use of high quality water is a need that speaks for itself. Industrial use of water again involves commerce, and there are obvious health needs in water purification systems. Again, I maintain that these areas all have individual legitimate and necessary authority in these realms.

The Atomic Energy Commission has obvious authority in the area of radioactive materials. The Department of Health, Education, and Welfare has interests in the health aspects of these potentially harmful materials. The Department of Defense has needs for nuclear fuels, and every Department involved with water which is interested in desalinization as a source of additional fresh water has considered atomic facilities for such processes. These interests each have certain special concerns, and I feel that they are rightfully exercising authority in their own particular areas.

I could go on and on, but certainly it is not necessary. There is nothing wrong with his departmental specialization in related fields; it is advantageous for the Government to look at problems from a variety of specialized points of view. There are, however, some major needs which are not being met.

First and foremost is the need to view the entire environment and its total ecological interaction. It is essential to relate all of these areas of interest to each other. The environment is certainly composed of many more elements than have been mentioned here. And the ecology of the environment—the interaction of all of those elements—is something that I could not entirely explain here for we do not yet entirely understand it. That is my point. The understanding of our ecology is essential if we hope to successfully deal with the many problems of our environment. The understanding of our ecology is essential if we hope to create programs that will alleviate our environmental problems. Both now and in the future. The understanding of our ecology is essential if we are to make the various individual programs in our government relate effectively to one another, and to advance our activities in the realm of improving the entire environment. And effective overall view of the environment and its ecology will enable us to evaluate the effectiveness of our present efforts throughout the Government.

It is for this reason that I introduced the Ecological Advisers Act of 1967. This bill proposes the creation of a Council of Ecological Advisers in the Executive Office of the President.

The purposes of this Council are manyfold. Primarily this branch of the Executive Office is to provide an overview of the problems of the ecology of the national environment, and to recommend and develop ideas and concepts for the implementation of programs designed to improve, protect, reclaim, restore, and conserve the various aspects of our environment. The Council is to establish devices for reviewing the effectiveness of, and the need for programs throughout the Federal Government, or sponsored or supported by the Federal Government, in related areas of environmental or ecological quality.

The most important of the Council's tasks will be the relating of the various areas of environmental interest to each other, and the development of creative concepts and plans for the continual improvement of the ecological and environmental conditions of the Nation.

The Council is also to direct the coordination of the efforts throughout the Government by its appraisal of programs. Through its staff and research facilities, it is to streamline and coordinate the research activities of the various areas of Federal interest and involvement in ecological questions. The Council will also advise the President on the allocation of funds for the various Federal areas involved with environmental questions.

The overview of the Council will be directed at the entire ecology of the environment—from the point of view of man and his needs. Ecology itself is not a concept which directs itself toward the effect of the interaction of the elements of the environment on one individual organism or element. However, in the case of the Council, we are interested in the environment and its ecology as it relates to man. The Council should not occupy itself with the narrow definition of each constituent element of the environment, but rather with the overall interaction of the constituent elements as they relate to man through their interaction with each other and with man. The Council must take a larger and not a smaller view of the picture of the environment. It must take a creative and comprehensive look at the ecology of our environment, concerning itself not only with the physical implications of the environment, but with the psychological and sociological implications of the conditions and interactions of the ecology of the environment on man. This will certainly include both the man-made as well as the natural elements of the environment.

The need for such a Council is clear. I have been in contact with representatives from industry, Federal departments, the Executive Offices, and scientific specialists, and they all express the idea that, in one form or another, some type of overseeing body is necessary to deal with the ever-increasing and continually proliferating questions and areas of authority concerned with our environment. They all affirm that an ecological view is necessary. There is a need to develop a long-range view of the problem, and corresponding long-range plans. There is a need to see that those areas of the Government dealing with various environmental problems are able to bring all resources to bear on those problems, are using all of the material available to the Federal Government, are not duplicating other efforts and programs, and are far reaching and creative in their efforts—with an understanding of the relationship of their projects and work to other related undertakings, other places in the public and private realms.

It is only fair to ask questions concerning the placement of such a council at the level of the Executive Office of the President. Once the need for such a body was determined, careful consideration was given for the placement of such an overseeing policy body. During the course of deliberations, the places considered for such a governmental function varied from the new Cabinet-level department to an Assistant Secretary of Health, Education, and Welfare.

It has become increasingly clear that a body created to deal with the entire environmental ecology must be in a commanding place in the Government if it is to be in any position to get an effective overview of national efforts and is to be a far-reaching policy determiner. If it is to be such an overseeing body, it cannot be placed in the structure of any one department involved in any one area of ecological or environmental quality control. It could never oversee or direct the efforts of activities in other departments equal in stature to the department in which it was a subdivision. Therefore, creating an assistant secretary, or some such similar position in an existing agency would essentially be impractical and make such a body or position impotent.

On the other hand, there is no desire to create a "super department"—a department to collect all of the various environmental quality research and control functions rooted throughout the various agencies and departments. As stated earlier, there are certain specific areas which are best kept where they now are, and such a massive reorganization would only postpone further the needed advances in this field.

The logical place for this Council, therefore, is at the level of the executive. There, as a result of its position and its composition, and through its contact with the President, it is in a position to direct and enhance the activities in the Federal interests in environmental quality control, and to exercise independent and creative judgment in a previously much neglected field.

The power of this Council is derived from a number of areas. First and foremost is the position of the Council in the Executive Office of the President. The ecological advisers should be the executive equivalent of the Council of Economic Advisers, and through their function of reporting directly to the Executive on a regular and frequent basis, and recommending policy, programs, and allocations, the advisers maintain a prominent and powerful position in the Government.

The composition of the body also lends itself to authority both within and outside of the federal structure. The prestige value of a membership composed of experts and outstanding figures from a number of areas of private service should enable the Council to wield a great deal of influence in areas of environmental concern. The arrangement within the Council which enables the advisers to serve on the council without leaving their important positions in public and private life, enables, each individual member of the Council to maintain and enhance his own individual position of status in his area of specialty and influence.

The composition of the Council should be designed to include representatives of science, industry, and areas that are major concerns of environmental quality. The advisers themselves should be individuals who are capable of taking an effective overview of the situation, and not become involved with the particulars of the various programs which come under the purview of the authority of the Council.

For this reason I feel that the larger part of the Council membership be composed of social scientists, social and community planners, and public administrators. The great volume of the needed scientific expertise should come from the staff of the Council which will serve on a full-time basis. As previously mentioned, the Council members will retain their positions in public or private organizations in order to maintain positions of authority, and to help the member to maintain his specialized expertise and thus contribute more to the Council.

There is one additional underlying question which must be answered. This question deals with the concept of creating a new structure within the Government each time a problem is newly recognized, or appears to have grown or be growing. Should we create some new part of the bureaucracy every time we discover or redefine a problem? Of course we should not in every case or even in most cases. For we surely have the facilities within our gigantic federal structure to handle most problems. This question can honestly be asked of any new proposal, and it certainly must be asked of a proposal of such far-reaching proportions.

In the case of this plan I have introduced, I believe wholeheartedly that the need for its creation is clear. Our environment is our most immediate need. It affects us every minute of every day, and the ecology of that environment can alter our lives. This is not a simple problem, and therefore cannot be met by a simple solution. This is a problem that has roots throughout our country, and is dealt with in almost every area of the Federal Government. It is an area which includes environmental elements which must be actively related to each other if any valuable headway is to be made in the field of environmental quality control.

The possibilites of such a plan are very encouraging. The purview of the Council will deal not only with the interrelationship of the elements of the environment, but with the effects of those interrelationships on man himself. Only a Council in such a commanding position could be capable of collecting related information, coordinating efforts and projects, streamlining Federal activities in this rapidly growing field of interest, and developing the long-range and creative plans involving all areas of the Government which are necessarily involved in this realm.

Only a council such as the one proposed could have the latitude to develop such new concepts as the psychological implications of life in an urban area in terms of total ecology, and only such a council could be in a position to promote now unknown projects and concepts which are certain to develop in areas of urban and rural social ecology, and total concepts of waste disposal and related pollution abatement projects.

The need for such action is obvious. The environmental problems of this country are increasing daily and we must stop dealing with them only as they appear as blemishes on the national countenance. We must be far-reaching in our own efforts to establish a body with needed authority to view an immense problem from a comprehensive position and to develop effective solutions to complex and important problems.

(Prepared statement by Hon. James C. Corman is as follows:)

PREPARED STATEMENT OF HON. JAMES C. CORMAN, MEMBER OF CONGRESS FROM CALIFORNIA

Mr. Chairman, I thank you for the opportunity to testify in support of H.R. 14627, a bill I introduced January 16 of this year, to create in the Executive Office of the President a Council of Ecological Advisers.

The dictionary defines ecology as "the branch of biology that deals with the relations between living organisms and their environment; in sociology, the relationship between the distribution of human groups with reference to material resources and the consequent social and cultural patterns."

While our Nation has been blessed with an abundance of natural resources, our population has grown immensely and our environment has changed drastically. The responsibility to plan for these changes lies with all levels of government. And, we in the Congress must concern ourselves with the use and misuse of our resources as our population continues to grow and our environment continues to change.

We are now facing the problems created by air and water pollution, but we responded only after tremendous public outcries. And even here, our response has not been sufficient to permit real progress in the very near future, partly because we do not know enough about the ecology of our environment.

We must anticipate the problems that our changing environment will create so that these problems do not become insurmountable. Our knowledge in this area is scant. We must learn more if we are to provide a livable environment for ourselves and those who come after us.

My bill will take us in this direction.

Very briefly, it would create a Council of Ecological Advisers to the President. It would conduct studies of natural environmental systems; it would advise and assist the President on the formulation of national policy to protect, preserve and improve our national environment; it would seek long-range solutions to the problems created by man and nature; it would make such information available to all public and private organizations and individuals; it would coordinate research and promote cooperation among all agencies, organizations and individuals in the area of environmental study; it would give priority to the very important areas of air pollution, water pollution, solid wastes, atmospheric radiation and environmental noise.

The rapid rate of increase in population and the pressures on our natural resources and on our environment make the need for increased ecological research urgent. My bill will take the first step to meet this need.

Thank you.

Mr. DADDARIO. Our next witness is Dr. Richard Morse, who was the Chairman of the Panel of the Electric Automobile for the Department of Commerce, which recently published its report "The Automobile and the Air Polution, a Program for Progress."

Dr. Morse, we are happy to have you here this morning and are anxious to hear from you.

(Dr. Morse's biography follows:)

DR. RICHARD S. MORSE

Born: August 19, 1911, Abington, Massachusetts.
Degrees:
  S.B., M.I.T., 1933; Tech. Hoch, Munich, 1933–34.
  D. Eng., Brooklyn Polytechnic Institute (honorary), 1959.
  D. Sc., Clark University (honorary), 1960.
Field: Technical Management, Research and Development.

PROFESSIONAL EXPERIENCE

1934–35: DIC Staff, M.I.T.
1935–40: Scientific Staff, Eastman Kodak Company.
1940–59:
  President, National Research Corporation.
  President, Vacuum Metals Corporation.
  Director, Escambia Chemical Corp., Columbia-National Corp., New Enterprises, Inc., Leybold Hochvacuum G.M.B.H.
  Chairman, Army Scientific Advisory Board.
  Member, Defense Science Board.
1959–61:
  Director of Research and Assistant Secretary of the Army (R&D).
  Distinguished Civilian Service Medal.
1962– :
  Senior Lecturer, Sloan School of Management, M.I.T.
  Technical Advisory Board, U.S. Department of Commerce.
1965– :
  U.S. Department of Commerce Study Panel on Innovation and Invention.
  Chairman, U.S. Department of Commerce Panel on Automotive Vehicle Pollution.
  Trustee: Midwest Research Institute; Research Analysis Corporation; Marine Biological Laboratory.
  Chairman, New England Council Committee on Science and Technology.
  Director: Dresser Industries, Inc.; Japan Fund, Inc; Air General, Inc.; New England Council; Research Analysis Corporation.
  Member, Advisory Board, Air Force Systems Command.
Home: 330 Beacon Street, Boston, Massachusetts, 02116.
Member. American Chemical Society, St. Joseph Botolph Club, Algonquin Club, Quissett Yacht Club.

STATEMENT OF DR. RICHARD S. MORSE (MEMBER ON THE PANEL OF THE ELECTRIC AUTOMOBILE), THE DEPARTMENT OF COMMERCE

Dr. MORSE. Nice to see you, sir.

I don't have any prepared statement as I believe was agreed before my coming down. I do have a draft of a talk I gave recently in Detroit to the Society of Automotive Engineers which summarizes some of my thinking with respect to certain aspects of the auto pollution problem.

If you would like to have that in the record, I would be glad to send you a copy of it.

Mr. DADDARIO. We would be pleased to have it.

Dr. MORSE. This touches on some of the subjects some of the previous Congressmen mentioned this morning. I am impressed with the sound thinking they have given to this subject. In view of the kind remarks you have made to the other Members of Congress this morning, Mr. Daddario, I would be remiss if I didn't say that my scientific friends look to you as the guiding light in this area here in Washington. I have always found it a great pleasure to talk with you because you understand and are concerned with the technical aspects of our complex national problems.

Mr. DADDARIO. You are very kind. I am not used to such kindness before noontime.

Dr. MORSE. I am not entirely sure what you would like me to say, but perhaps I might briefly refer to the genesis of this report dealing with the auto industry air pollution problem.

Mr. Daddario. I think it would be extremely helpful. This is one of the areas not only of great importance, but one which naturally attracts the thinking of the public. An explanation of it could be extremely helpful to us, Dr. Morse.

Dr. Morse. In late 1967, the Technical Advisory Board of the Department of Commerce, of which I have been a member since its formation, addressed itself to the question as to whether it would be appropriate for such a body to look at the auto industry air pollution problem. It is fair to say that the stimulation for this action probably came from Senators Muskie and Magnuson who, as you know, have had great concern for our pollution problems and have done a very fine job.

Subsequent to this meeting of T.A.B., the Secretary of Commerce established a Panel of some 16 members and asked me to serve as chairman. Simultaneously with the establishment of this ad hoc study panel by the Department of Commerce, other departments within the executive branch, and Federal agencies, indicated their desire to become associated with the study. This included HEW, Department of the Interior, Department of Defense, Housing, and Urban Development, the Atomic Energy Commission, Post Office, Federal Power Commission, and the Department of Transportation. Each of these organizations supplied a certain amount of money for expenses and staff assistance. People on my committee served without pay.

I would like for a moment to talk about the panel because we have had some talks today about the possibility of establishing a Council of Ecological Advisers. I am personally allergic to committees as I'm sure we all are, unless they are effective and can implement their findings.

This particular panel was an interesting one and followed the pattern of a previous panel of the Department of Commerce—the so-called Sharpie Panel, dealing with innovation and invention.

Within the panel itself we had members drawn from a variety of segments of society with diverse technical, scientific, and industrial backgrounds. We had people from industry, universities, and government.

I think it was important that we had the same approach as the Sharpie Panel, where we had lawyers and scientists, engineers, inventors, business people. It is only by establishing study groups with this kind of a composition that you can get objectivity.

A panel of our type may create some heated dissension, but in the process of the deliberation, it also gets education. In both of these study groups the panel members learned as they went along with their evaluation process. Furthermore, this study dealing with the automobile pollution had representation from more than one department in the executive branch. I think this is also important in attacking a problem, which as mentioned by some of the earlier witnesses, does transcend the responsibility of any one department.

Otherwise, I think we might have turned in a written report—a Commerce report—and then HEW might well say, "That's fine, but let's now set up a committee to look at the report of the committee." Action would be delayed and the usual interdepartmental conflicts would be magnified.

With representation from all of the responsible agencies, some with divergent views and interests, and staff from these agencies working with all of us in concert, I think that we came up with a report which perhaps has a better prospect for implementation than might otherwise have been the case. Some recent actions of HEW suggest that this is true as a matter of fact.

This also meant that we could get on with the job fairly fast. We had a very hard working group.

Almost immediately after the panel's creation, I was successful in getting some 40 additional people to serve on subpanels with specific expertise in required areas of competence. We then broke the job down into components, and set up subpanels, dealing with such topics as the total U.S. energy sources; the requirements of the country for the next 50 or 100 years or more; turbines, steam engines, fuel cells, batteries; air pollution, current gasoline engine, etc. We had medical people specifically acquainted with atmospheric problems and the health aspects of pollution. These subpanels, then, looked in depth technically in their area of competence, and then the panel as a whole tried in its best judgment to evaluate the data developed. In the evaluation process we just didn't have medical or business people, scientists, or physicists or chemists, but a composite group of broad experience in science, industry, and government.

We may have come up with somewhat tougher recommendations, perhaps, with respect to our recommended action, if we had reflected the majority view regarding recommendations. By arriving at a report in which all of the members concurred, call it consensus or what you will, I think perhaps we did a better job and are now in a better position to recommend action than might otherwise have been the case.

I was impressed with Mr. Tunney's last statement about management. All through our studies that was one of the things with which we were greatly concerned. Technical problems are relatively simple. If you get competent people to sit down and analyze, let's say, a zinc air battery, or a sodium sulfur battery, against some fuel cell, or steam engine, you can develop factual data that can be interpreted with a high degree of certainty. You don't argue about these technical problems.

When one examines the question of how to run an organization, or how the Government should get on with the job, there are differences of opinion and shades of view. Judgment and experience becomes important.

This question of management is terribly important in industry and Government, particularly in our changing technological society. From a broader viewpoint this country has a very difficult task right now in many areas and particularly in the allocation of our scientific and engineering resources as a whole, if we are to solve many national problems. There are only so many people. It is all very well to talk about let's set up another department; let's have another Council. Councils and committees are composed of people; there aren't many available people that know this game—let's say of ecology, for example.

Mr. Daddario. Isn't it precisely because there are so few people with competence in this area that the management situation becomes more important?

Dr. Morse. I agree. You have to use them more effectively; certainly.

I find on the outside in setting up a committee when you start looking who is on the committee you pull out the same names in the file down there the last 10 years. These people are all busy—the good ones. I think we have to address ourselves more effectively to management problems, and as you and I have discussed before, I am particularly concerned about a better use of our scientific and engineering resources in areas such as this as to the problems in the air and on the earth's surface.

One of the other items which we reviewed was the lack of innovation and perhaps lack of underevaluating of the innovation process within the auto industry.

I must say also that the more we studied the automobile industry problem, the more we realized that the industry also had problems which perhaps the Government people didn't appropriately appreciate. The time factor of getting into mass production, questions of antitrust, and the economic problems, for example.

On the other hand, innovative ideas have not come forth from Detroit at a startling rate. We recognized this and said so.

I think we should realize that the California smog from a scientific point of view, was at least understood, in the very early 1950's; that is a long time ago. It is also fair to say that without the relatively prompt action on the part of the State of California, we wouldn't have the air pollution situation even under control as much as we do today with respect to standards for automobiles.

The Federal Government has been considerably behind California. On the other hand, we must again recognize a very difficult problem, presented to us by many people: Why should somebody in let's say northeast Maine, pay something more for an automobile because California people need to have an antismog device? This is a practical problem evolving production costs, the use of cars in interstate travel and so forth. You can't have three or four different production lines in Detroit.

We were faced with many of these kinds of decisions during our deliberations, and in many cases we just had to make a judgment. I think by having a committee with a high level of competence, and more particularly with diverse backgrounds of experience, our judgments had some merit.

Again, on the technical side, the question, when you came to discuss the organization was: What should you do about a standard, let's say, for a product that you really didn't have good health data on? It was then a matter of judgment and it was tough.

In general our subpanel technical reports suggested more rigorous positions, but when the panel as a whole looked at the subpanel recommendations, we tried to develop a broader viewpoint.

Mr. Daddario. What does your experience lead you to tell us about health? What do or don't we know about it? What judgment should we come to? How do we reconcile these problems as we deal with this in the future? Should we not be looking way down the road so that we can learn more about the health problems?

Dr. **Morse**. We started out with our first recommendation to the effect that "the national goal for air quality should be the achievement of an atmosphere with no significant detectable adverse effects from air pollution on health, welfare, and quality of life."

We thought it was important to set this goal for America because it can be achieved.

We had a number of people, both witnesses and one or two people, as a matter of fact on our committee, who felt that we should place a dollar sign upon the quality of air. I don't happen to subscribe to that although we must be practical. The statement "no significant detectable adverse effects was set as a goal. Obviously, if you have a goal you are going to do your best to get there. If you have technical problems, or economic problems, or funding problems, you obviously aren't going to get there.

It seemed to us that somebody ought to make that statement. We have enough science and technology in this country if we can marshal our resources to achieve such a goal. Time is running out and we should have started long ago.

You won't do it in every part of the country. You won't do it in the Lincoln Tunnel or obviously a few other places for some time to come. You probably won't do it in Los Angeles, Boston, or New York for awhile.

We have some 80 million vehicles in this country, and we are generating let's say some 10 million new autos a year, and taking 2 or 3 million off the road. With this massive flywheel underway, no matter what you do today, to new cars there isn't much effect, because of our backlog and number of vehicles. The same large national problems apply to the numbers of plastic bottles we are throwing all over our beaches which are going to be there for years to come because they do not rust and decay. The noise problem of our industrial life is also getting out of hand. You have to move in earlier on these things or you will never really make an impact on the solution to the problem because of its massive size and increasing importance. Our European cities and Tokyo are now finding it too bad they didn't start earlier in their war against pollution. Their rate of increase of vehicles is substantially greater than in the United States; they already have their vehicles in production, without controls and did not benefit from our mistakes.

We found a dearth of quantitative data in the health area. As you know, when you get in the medical field, it is a little difficult to get people to be precise. But we certainly had an abundance of information—not by specific pollutant in many cases—but good data to show that in areas of urban living, health of our people does deteriorate. This is not as simple a problem as the cigarette-cancer matter. You have different pollutants in the air, different meteorologial conditions. The general case is pretty well supported to show that pollution is bad for you. There is no question about that. But we can't say *x* number of people died from nitric oxide, or *x* number of people died from carbon monoxide; we don't have reliable information in that specific sense.

Mr. **Daddario**. How difficult is the problem that faces us? Do you find it to be an unmanageable one? Should we be developing the ways and means through which this information can in fact be obtained so that we can establish the criteria with greater confidence?

Dr. Morse. Well, with respect to your first question, Mr. Daddario, I think we can get the data. We have not organized research and collection programs appropriately to get the information.

Mr. Daddario. Do you think we should?

Dr. Morse. Yes; I think we should. Furthermore, I think we must continue our research with respect to health effects on a long term basis. We also need better economic data and information regarding the impact of pollution on agriculture, materials, and resources in general.

Mr. Daddario. What would be your judgment, taking into consideration the experience you have, as to how dangerous the situation is? What might we find out as a result of the statistics which we would gather through such a procedure?

Dr. Morse. You are talking about impact on health?

Mr. Daddario. Health-wise.

Dr. Morse. I don't think I would want to guess on that one and my committee had varying views. We had many medical people talk to us. We had, for example, curves showing the correlation between deaths against the smog content in Los Angeles in old-age people's homes, but this problem is a difficult one. Somebody might say, "They are going to die anyway," as they were 70, 80, or 90 years old, so this doesn't mean anything. This attitude doesn't impress me as a responsible view to an obvious adverse effect of pollution.

Mr. Daddario. I hope not.

Dr. Morse. No, but I can tell you the kinds of things we were concerned with.

Mr. Daddario. Sure.

Dr. Morse. I don't think I could possibly guess the deaths or decrease in life expectancy resulting from pollution, I wouldn't know how to express it quantitatively. Air pollution does impair this country's quality of life and definitely impairs health.

Mr. Daddario. We find ourselves facing this dilemma: On the one hand, many people say to us, "This is just a harum-scarum situation, and it is really not so bad and therefore we ought not to be spending as much money as we are."

Dr. Morse. Well, we are not spending much money.

Mr. Daddario. And others who say, "It is so bad that we ought to be doing much more." We could by just guessing, do the wrong thing altogether. The automoile exhaust situation which you mentioned is a device added to the cost of the automobile which each year comes up to some $500 million. Many people feel this is an absolute necessity. Others have tried to convince us that it is not.

If you take this problem and spread it out into many other areas such as the bottle and its disposal problem you have a tab of hundreds of millions. In the sewage area, we are talking about estimates of $100 to $150 billion. When you ask people, "Why do we need to do it?" nobody can really prove that separation of storm and sanitary sewers is going to answer the problem, and make everything sweet and pure again.

Unless we do have base line criteria, the expenditure of public funds then becomes a real problem. We do look, Dr. Morse, toward you and others who have had to thread your way through this morass and develop through experience, judgment capabilities of what we ought to do. I agree with you wholeheartedly it is better to come to a judgment and do something sooner, rather than later, and take perhaps the chance we spend a little more money than perhaps we ought to.

Dr. MORSE. I think you will save money in many cases by making earlier decisions. I think we would have saved money if we had adopted more stringent standards earlier in the auto case. I am almost sure you will have saved the country money. Now we can't go back to fix used cars, to put in the test facilities, and inspection facilities needed for such an exercise.

Mr. DADDARIO. You were somewhat critical in your earlier remarks that Detroit was not reacting as quickly as you would like.

Dr. MORSE. I think historically that was true. As far as the study activities with which I have been associated, we have had good cooperation in Detroit, from the industry executives at the top, and from the laboratory people. We talked to them in the early course of our study suggesting that they should get together with the oil people in cooperative research. I'm glad to say they are now doing this. We now have a number of auto-oil industry compacts, which never existed before.

However, in 1952 we knew the nature of the chemical smog reaction in California. It is only within relatively recent years we have really done anything about this problem.

That is the thing that concerns me. There wasn't any considered technical management appraisal of the problem within the States, within the industry or within the Federal Government at an early enough time period. There is no new technology or new science required to make a substantial reduction in automotive exhaust systems. Essentially nothing has been put on a car the last 3 years that couldn't have been put on 10 years ago. That is what I am addressing my statement to. It is also my guess that the really innovative ideas in this general area very well came from outside the auto industry.

Mr. DADDARIO. I think that is extremely important.

Dr. MORSE. The mechanism is lacking.

Mr. DADDARIO. How do we take advantage of this and keep developing these capabilities and keep getting more and more people involved?

Dr. MORSE. Are you speaking of the Federal Government, particularly.

Mr. DADDARIO. Mechanisms within the country including the Federal Government and bringing in outside people. I would expect when you brought your people together you had many of them working as a labor of love, really.

Dr. MORSE. Right.

Mr. DADDARIO. So you are able to get people to do these things, providing you can show leadership and can give them an opportunity to participate?

Dr. MORSE. Many of these problems should be attacked at the State or local level. With few exceptions this is very difficult, because within our States we don't have the technical, scientific, or management competence, or even a willingness to communicate with outside experts on this subject. I think this is a real serious national problem.

At the Federal level there is no difficulty in getting people who are both concerned and willing to work on important problems.

The real question in my mind comes down to the delegation of authority and responsibility to implement actions at the Federal level in cooperation with the States.

Now the President has, as you know, stated, and written, that the Secretary of Health, Education, and Welfare has primary responsibility in such areas as air pollution.

Our committee, and I'm trying to speak both as a former panel chairman and as an individual, felt that within HEW the responsibility for air pollution should be raised to a higher level than it was and is at the present time.

There is a great hue and cry about automobile safety; and yet, in actual fact, I think the air pollution problem is a far more complex, difficult, and important problem perhaps than safety. Complex in the sense that you are affecting the oil industry, supplies, tires, and it is a difficult situation. You are going to deal with the States' monitoring and inspecting, and because of the excitement about safety, this was raised to a very high level, and then perhaps very appropriately so, but the responsibility in the pollution area in HEW is still not perhaps at a level where it has appropriate visibility, nor does the group have authority and responsibility to perhaps do it as rapidly as they might. It is a great improvement over the past.

Mr. **Daddario**. Great improvement at the State and local level?

Dr. **Morse**. No, within HEW.

Mr. **Daddario**. Within HEW?

We went into this State and local problem a little bit during the course of these hearings.

Congressman Oren Harris was particularly concerned about the Federal Government getting involved in the area of local responsibility in solid waste and garbage disposal. As we talked about that the Government witnesses felt that we were able to put together the technical advice which a State-local government had to have in order to improve its situation and give them alternatives. The judgment ought to be left to them so that they could in the final analysis make the economic determination. The problem does appear to be that in many places there is a technical and mechanical inability to do that.

Do you see this as being a problem that cannot be overcome? Do you see the Federal Government necessarily having to do all of this?

Dr. **Morse**. Well, in general, I would like, from a management point of view, to see more national programs and their management and implementation, decentralized. You can't do everything in the Office of the President as we all know.

In the case of things such as national air quality, or the collection of environmental health data, among cross sections of the population, by age group, and occupation, it seems to me that this probably is going to have to be implemented and managed by the Federal Government, hopefully on a well-organized, long-term-program basis.

I am concerned, however, that such work for example, should be performed as a long-term managed program. I think historically we had a tendency to undertake disorganized small research projects in the form of grants as NIH does basic research, National long-term research and development efforts require a good program and a good manager with authority and responsibility. This is true in this area of research, whether it be performed in a university, industry, or government.

It isn't practical to have industry run it. You have industry participation, obviously. The Federal Government should organize and fund our efforts in this area of health effects from air pollution, because the problem is national and international in scope. We are talking long-term health trends, and the program requires careful planning and implementation.

Mr. Daddario. Getting back to the management situation in government, your panel had representatives of the various agencies. What inhibiting factors did you see which prevented these agencies from working together in a better manner?

Dr. Morse. During the course of our panel activities—this went on for about a year—we did not really encounter any serious problems between individuals. If you have good people, it doesn't matter where they come from. In Washington one always has conflict between agencies because of their desire to get programs and funds. It has always been the competition for funds and program responsibility that create interdepartmental problems and conflicts. We had no difficulty in arriving at essentially the same conclusions on almost every topics to which we addressed ourselves.

I think it is quite clear that HEW has the responsibility for getting medical data, or other air pollution information, in order to develop criteria for air quality. They clearly have the responsibility to establish both such criteria and standards.

If suppose you talk about the urban problem, either in terms of intercity or intracity transportation, from the point of view of pollution then interagency conflicts are presented.

Who has responsibility for developing new nonpolluting transportation systems, or engines, that is, HUD, Department of Transportation, HEW, or Interior? In this area we need a clear delegation of authority and responsibility. If you start talking about burning low sulfur content oil, you might have an interdepartmental problem. Interior is interested in oil resources; the Atomic Energy Commission has an interest in promoting nuclear power. There is perhaps need for improved coordination between HUD and Transportation and HEW. I think it is in the nonhealth areas where perhaps we have our major potential coordinating and conflict problems in Government.

It has been my experience in Washington that if you have rank and money, and are not running for office, you can get a lot accomplished if you want to. In this business you cannot please everybody and get anything done.

Mr. Daddario. We have looked into the necessity of the health-related and nonhealth-related problems being properly coordinated. I agree with you this is a problem. We have to pay some attention to the management situation because it does seem to me that it is in everybody's interest to use their resources in the best possible way.

You might talk about the question of lead in gasoline. This is part 1 of the report you referred to.

Dr. Morse. Yes.

Mr. Daddario. On page 4 you have a recommendation regarding lead, and on page 24, you say:

These uncertainties, with their corresponding health and economic impacts, dictate immediate action if the risks are to be reduced. As a minimum, steps should be taken to assure that current atmospheric lead levels are not exceeded.

How did you determine what lead levels we ought to have? Not having the health situation nailed down and considering the economic impact, how do you make a determination as to what ought to be done?

Dr. Morse. Let me tell how we approached that problem.

We had a subpanel concerned with the environment under Professor Eliassen, who is professor of environmental engineering at Stanford. He has been in the general field of environment for his entire professional life. He had associated with him a number of medical people, technical people and management people. They held meetings with people from the Rockefeller Institute, Harvard School of Public Health, the State of California, New York City Department of Air Pollution Control, etc.

It was the recommendation of that subpanel that the potential risks associated with lead in the atmosphere were potentially high, on the basis of a number of considerations. As I mentioned previously, we had this question of the backlog of 60 million autos and 80 million vehicles. You can't do much about that; they are here. You can't change the engine; it is impractical.

Therefore, in view of the potential risk, the continuing increase in autos, and the increasing amount of lead, as the larger sizes and numbers of engines are built, they felt we should begin to reduce the total lead content in the atmosphere. These experts recommended a 10 percent per year lead reduction and this was submitted to the main panel as a whole. After great deliberation we felt on the basis of a judgment factor that it would be inappropriate to take such action. Bear in mind the decision was in the absence of specific quantitative information that people are dying because of lead. There is no data to substantiate this viewpoint. The risks of increasing lead content in the air may be very high and other reasons dictate a serious consideration of its reduction.

Members of the subpanel on air pollution included Professor Eliassen of Stanford University as chairman; John R. Goldsmith, chief, environmental hazards evaluation unit, California State Department of Public Health; Eric P. Grant, executive officer, Los Angeles Motor Vehicle Pollution Control Board, Calif.; Austin N. Neller, Commissioner of the New York City Department of Air Pollution Control, N.Y.; Alan G. Loofbourrow, vice president-quality and reliability, Chrysler Corp.; Robert W. Schiessler, vice president-research, Mobil Research and Development Corp.; James L. Whittenberger, of Harvard School of Public Health; Arthur C. Stern, of the Department of Health, Education and Welfare.

In addition this group talked to a number of other technical people and medical people in the field and had the benefit of our other panel xperts who were concerned with a reduction in lead for other nonhealth reasons.

After a lengthy deliberation on this lead subject by our panel as whole—and it was the main panel which of course prepared the ecommendations, we felt that we needed more information in the ealth field. Because of the recommendation of the subpanel from a health point of view, because of a small amount of information that lead may affect weather, and possible future needs for catalytic devices to produce lower auto emissions, we decided that the risk of a futher increase in atmospheric lead content was too high to be tolerated at this time. But our technical experts are of the unanimous opinion there is no catalytic device which will operate on a muffler as to today, which will operate in the presence of lead.

Again, trying to anticipate technology ahead, because of the massive current number of autos, we ought to do something, not wait until the problem becomes insoluble. Because of all of these reasons, we felt that HEW should obtain better quantitave data on the health aspects of lead, and we should in fact stop increasing the lead in the air now. That is a matter of judgment. You can say we ought to cut it 20 percent or we ought to forget it, but with all these factors involved it was the considered judgment of our people, that we just could not take the risk of increasing lead every year. Ten years from now we would be at another hearing, we would look back, and say, "Gosh, I wish we had done it then."

Mr. DADDARIO. How are you affected by people who have come to their judgment on these things as a result of their participation in the situation as in Los Angeles?

As we look at these things, Dr. Goldsmith is on your panel, he is also on the panel in California. The language in both instances, seemed to be almost the same. The reference to the need in California, and the standards you have set there, are understandable. What kind of judgment goes into determining how you apply this to the whole country? And should it in fact be applied to the whole country?

Dr. MORSE. You are still discussing lead?

Mr. DADDARIO. Yes.

Dr. MORSE. I want to make it clear our deliberation with respect to lead paid little attention to the California problem. Atmospheric pollution in California is quite different from New York. The smog problem is not aggravated by lead. There is no established association between lead and smog. So that really was not a consideration. The question of lead, from a health point of view, comes up in those instances where you have let's say garage mechanics working near an auto, you have policemen associated in heavy traffic conditions, not California.

One of the major automobile manufacturers, for technical reasons, not health reasons, was very interested in making a substantial reduction in the tetraethyl lead content of gasoline. They felt this eased their problem of designing an engine and control devices to meet the characteristics which they can anticipate in the future. This was a technical economic consideration, not a health consideration.

Another automotive executive didn't agree with this viewpoint. That is where the deliberation and judgment factor of our panel came in. We had a very strong recommendation from one of the major auto people that they would like to see lead reduced substantially, and in addition the octane rating of gasoline reduced, and the compression ratio. If you in fact reduce the octane rating of gasoline and the compression ratio of our engine, then it may not cost more money to use nonleaded gasoline.

These are the kind of arguments we had for many weeks. And after filtering out all this information we didn't think we ought to say, "Stop putting tetraethyl lead in gasoline." We should at least take a good look at the problem now and we ought to stop increasing the current potentially high level of lead in the air.

Mr. **Daddario.** The reason I asked you about this is that people are disturbed. It seems that Los Angeles is the base of the criteria on which you make these judgments.

For example, on page 8, of part II. On the right-hand half of the page, the first paragraph goes into that, substantiating what you have said that there is not sufficient medical evidence, which qualifies your statement, that there is no medical evidence, or not sufficient. Then you say:

> Accordingly—

In the last sentence—

> in certain metropolitan areas such as Los Angeles County, the present levels of atmospheric lead are considered to present a public health hazard and it would be a prudent public health policy to prevent further elevation of atmospheric lead levels in such areas as well as to take reasonable steps to reduce them.

The judgment here appears to be based on there being some medical testimony.

Dr. **Morse.** Oh, yes.

Mr. **Daddario.** Since Los Angeles has this problem, others ought to be careful of not creating the same problem. This is the reason I ask the question. I think in a sense you clarified it.

Dr. **Morse.** I just want to make it clear that the smog problem in Los Angeles is not the air pollution problem in other areas. It is a unique kind of problem because of geography, and the atmosphere, and lead does not contribute to that. We didn't come to our conclusion regarding lead because of Los Angeles, but after all the evidence from a number of aspects on a national basis.

Mr. **Daddario.** How did you work out the problem when the idea came that you ought to reduce this 10 percent per year, as you said it would have disruptive effects? What were the economic considerations which fit into that? How did they lead to other judgments, if they did?

Dr. **Morse.** Well, we tried to strike a balance between practical recommendations, and one which would just be totally unacceptable economically, particularly in areas where there wasn't quantitative data that showed a health problem. I don't know how you would place a value in dollars upon, to my mind at least, the untenable situation of even living in Los Angeles. How do you evaluate the fact when you get up in the morning you can't see very well? I don't know how to put a dollar sign on that one.

The impact of pollution on the quality of life is difficult to consider in the usual cost effectiveness way. Fortunately the American Petroleum Institute had just made a very competent report, with respect to the capital investment and increased operating costs associated with producing nonleaded gasoline.

We looked at that. We had close collaboration with all the automobile manufacturers, and we weighed their judgment as to whether they really wanted to run engines at current high compression ratios in the future. Nonleaded gas can, and is being sold in this country now but it is expensive to convert to nonleaded gas if high octane rating gas is also required.

Our discussions envolved judgment based on careful technical health and economic data.

Mr. DADDARIO. I understand that.

Dr. Morse, I think you have done remarkably well, considering the economic and technical factors involved to have made any headway at all because these economic judgments can be prevailing ones. The discussion seems to get us constantly back to the point that we need to have better medical knowledge.

At that stage of the game the economic judgments would be that much easier.

Dr. MORSE. The auto pollution problem isn't the cancer-cigarette problem. I don't care whether you smoke cigarettes or not; that is your problem. I don't particularly care if my own car has harmful emissions, but I am interested in the cars that others drive, if I'm driving through a polluted environment. There is, therefore, no incentive for the individual to worry about his own auto as an emitter.

We also recognized that there has been no economic incentive for any one of the automobile manufacturers to make a low-polluting auto. I think we have to appreciate that. They are in business to make money. They should be. This is our free enterprise system. It is a highly competitive business. Neither Ford, Chrysler, nor General Motors, or American Motors can add $50 to their costs just because they want to be good citizens—because they are competing right across the line, car for car.

I'm glad to say that during our deliberations I talked to many automobile executives and had many constructive discussions. They all said, "we accept the role of the Federal Government to set reasonable standards. This is the only way the problem is going to get solved."

I was surprised to hear that, and I was delighted. All they wanted was to have realistic standards that didn't completely disrupt their production line, and they wanted these applied nationally. They also wanted to be sure that such standards applied to them and all their competitors. They would fight out their problems technically and engineeringwise, do the job, and still make a profit.

The establishment of standards and their effective date of enforcement presents many problems. We tried to spend a great deal of time in trying to establish the exact technical status of all pollution control devices and then effectiveness and future prospects. I hope that we clarified that situation so that HEW can set realistic standards which will be acceptable and which will work at the earliest possible time.

I would like also to point out that pollution does not only effect health. We should also recognize the impact on agriculture, particularly in California, and areas near high densities of autos.

Frankly, I don't know the economic impact of air pollution on agriculture and more quantitative data is needed. This seems to be a serious matter and must be given serious consideration.

Mr. DADDARIO. There is no question that there is an agricultural problem.

Dr. Morse. There is no question.

Mr. Daddario. Connecticut, for example, tobacco.

Dr. Morse. And fruits and vegetables in California and Florida.

Mr. Daddario. We have gone to tremendous studies of the need to develop new strains of tobacco to overcome this particular problem. You go to the experimental station in New Haven, you can see the pock marks that come up in your tobacco leaf because of polluted air.

Dr. Morse. This is why I would like to be more responsive when we say we need more quantitative data. Recommendation No. 1 of our report sounds perhaps a bit bland but as a nation we should recognize the great advantage of really having a kind of life that is pleasant and not put a dollar sign on clean air. In every airport we now have a haze, a brown smoke in some cases. Is that good? A whole generation of Americans now have never seen the clear clean air that is now only available in relatively remote nonurban areas of the United States.

Mr. Daddario. Everything you said, of course, Dr. Morse proves out that you are not in the camp of those that believe we ought to develop a tolerance for this. The fact we develop new and additional strains of tobacco all the time to meet this is not the answer to it.

I am particularly impressed with the way in which you have come to some judgments in a very difficult area. It does give us, you know, dealing in the environmental area here today, some opportunity to look into how you have assessed this situation. The Congress is concerned at the moment about being able to develop for itself a technology assessment capability, because the legislative process begins to involve more and more scientific-technical problems. You have looked ahead with very little really to go on and I think this has been an extremely commendable fact. I raised some questions, and will have other questions to raise as to how these problems can be better approached in the future.

I'm particularly pleased that you have come to give us a hand here again. We have strayed away a bit from some of the things that we wanted to talk to you about, but this morning has been very helpful.

Any questions?

Mr. Felton. No.

Mr. Daddario. Thank you, Dr. Morse.

This committee will adjourn subject to the call of the Chair.

(Whereupon, the hearing was ended at 11:50 a.m.)

APPENDIX A

Staff Meetings on Environmental Quality

THURSDAY, FEBRUARY 15, 1968

House of Representatives,
Committee on Science and Astronautics,
Subcommittee on Science, Research, and Development,
Washington, D.C.

Mr. Joseph M. Felton, counsel, and Mr. Richard A. Carpenter, Legislative Reference Service, Library of Congress, met with Dr. John Middleton, Director, National Center for Air Pollution Control, and other officials of the Department of Health, Education, and Welfare, in room 2062, South Building, HEW, at 2:20 p.m. Accompanying Dr. Middleton were Mr. S. Smith Griswold, Special Assistant to the Director, NCAPC; Dr. Emanuel Landau, statistical adviser, Office of the Associate Director for Criteria and Standards Development; Mr. Thomas F. Williams, Chief, Office of Legislative and Public Affairs; Mr. Irwin Auerbach, Chief, Legislative Section, Office of Legislative and Public Affairs; and Dr. Bernard Steigerwald, Chief, Office of Program Planning and Evaluation.

Mr. Felton. First of all, I would like to thank you for meeting with us this afternoon. As you know, Mr. Daddario indicated at the hearing that the subcommittee would send written questions to you. Subsequently, he decided it might expedite matters if we sit down across the table and discuss these things back and forth.

You have a copy of the general questions we propose to cover, so I do not think we should have any problems.

The question I want to start with has to do with the definition of who we are talking about when we use the word "persons" in the act.

Can you give us some idea of what you have in mind or what you consider to be "persons"? Is it someone who is sick, healthy, old, young, or is there some norm to which you direct these criteria?

Dr. Middleton. Your question, then, is, what air quality criteria are, or, in other words, what they mean. The answer is that air quality criteria are an expression of available scientific knowledge of the relationship between various concentrations of pollutants in the air and their adverse effects on man, animals, vegetation, materials, and so on. Criteria are descriptive. That is, they describe the effects that can be expected to occur whenever and wherever the ambient air level of a specific pollutant or combination of pollutants reaches or exceeds a specific figure for a specific time period. Insofar as human health is concerned, air quality criteria reflect knowledge derived from epidemiological, statistical, and clinical studies of illness and death in the general population as well as among special groups in the population.

Mr. **Felton**. Let me frame the question in another way. I assume, for example, that we would not abate traffic going to New York because one person may get sick. Would these standards protect the sickest?

Dr. **Middleton**. That is a different question. Air quality standards are not the same thing as air quality criteria. Air quality criteria describe the air quality that must be achieved to prevent the occurrence of various adverse effects on health and welfare. Air quality standards prescribe the air quality that a State or community has decided it will actually try to achieve and maintain. This decision must, of course, be influenced by knowledge of the adverse effects of air pollution, as presented in air quality criteria, but it will also be influenced by economic, technical, legal, and other factors. So it is in setting standards that a State or a community decides the extent to which it will actually try to protect people, the extent to which it will actually try to prevent soiling and damaging of buildings and materials, the extent to which it will actually try to prevent injury to vegetation, and so on.

Mr. **Williams**. Under the Air Quality Act of 1967, Mr. Felton, we are charged with developing and publishing air quality criteria; in addition, we will develop and publish data on air pollution control techniques. Then it will be up to State governments to set air quality standards and develop plans for implementation of the standards. It is at this stage that States will, first, be prescribing the air quality they will actually try to achieve and maintain in air quality control regions we designate, and second, prescribing schedules for accomplishing this. Since the Air Quality Act requires State standards to be consistent with the air quality criteria we publish, this will mean that their standards must be at least good enough to protect people's health. Economic and technical factors must be and will be taken into consideration primarily in the formulation of plans for implementation of the standards.

Dr. **Middleton**. I think it would be well to refer to the introduction to the sulfur oxides criteria, published by the Department in March 1967. I will read it slowly.

> The criteria presented here then are not exact expressions of cause and effect that have been replicated from laboratory to laboratory. Instead the criteria are useful statements of the effects of the sulfur oxides in the atmosphere derived from a careful evaluation of what has so far been reported.
>
> As more studies of these effects expand our knowledge the criteria will be modified accordingly.
>
> The use of these criteria by State and local governments may vary with individual judgment and with local circumstances. In the Federal Clean Air Act the American people have expressed through their representatives a strong desire for clean air. Guidelines for the choice of criteria are that the quality of the air be good enough that—

Now there are seven points—

> 1. The health of even sensitive or susceptible segments of the population would not be adversely affected.
> 2. Concentration of pollutants would not cause annoyance such as the sensation of unpleasant tastes or odors.
> 3. Damage to animals, ornamental plants, forests and agricultural crops would not occur.

4. Disability would not be significantly reduced.
5. Metals would not be corroded and other materials would not be damaged.
6. Fabrics would not be soiled, deteriorated or their colors affected. And
7. National scenery would not be obscured.

I think here, then, you see that these are the kinds of things that we need to be concerned with, and that the criteria are the expression of the pollutant dosage that affects these particular items that we have enumerated. As Mr. Williams has said, it will be up to States to decide the extent to which they will try to prevent these things from occurring.

Mr. FELTON. Where did these seven points come from? Were they in the committee report? In other words, how did you understand this to be your mission?

Dr. MIDDLETON. This document is a document issued by the Department of Health, Education, and Welfare. It has a foreword on the part of the Secretary. It has a preface from which I read.

Mr. FELTON. No; I mean within the general guidelines of the act——

Dr. MIDDLETON. This is in response to the requirement prior to the Air Quality Act of 1967, that the Department published criteria on.

Mr. FELTON. I am not questioning that. I am just asking, where did the seven points come from? Were they mentioned by the committee in its report or by the chairman during the floor debate?

Dr. MIDDLETON. The seven were exercises of prudent judgment by our organization.

Mr. FELTON. I see.

I assume the criteria that affects No. 1 will be different—or I might put it another way. The concentration, if you will, as it affects No. 1 will be different as it affects No. 7?

Dr. MIDDLETON. I am saying the criteria for the sulfur oxides show the gamut of effects from one through seven. In other words, you may have very different pollutant concentrations with varying periods of times of exposure causing a variety of effects depending, among other factors, upon the nature of the receptor.

Mr. FELTON. Then it would be up to the States to determine standards, and if they felt free to exclude one of your seven, I would assume this would be permissible.

Dr. MIDDLETON. Yes; up to a point. If a State depended rather heavily upon its recreational values as a part of its real economic-social structure, it might wish to adopt standards that would preserve natural beauty. This is a State election, or local option, so to speak.

It is incumbent upon us to state what the dosages are that affect those things. The least a State or community can do is be responsible for the health of its people. It may wish also to be responsible for the health of things, protection of things. These are options that can be worked at different levels.

Mr. FELTON. I had not planned to go into it now, and perhaps it might be better that it be done later, but section 108(k) authorizes you to seek an injunction. I assume you would not seek an injunction for all seven of those reasons?

Dr. MIDDLETON. No. Because persons are not property. Therefore, the criteria that deal with persons, the dosages that affect people may be different, but not necessarily, than the dosages that would affect fabrics or trees or other things.

Mr. **FELTON**. So you would exercise section 108(k), then, only in relation to No. 1 or No. 2?

Dr. **MIDDLETON**. Health of people.

Mr. **FELTON**. Including sick people?

Dr. **MIDDLETON**. Health of all the people, including sick people. Let us not forget that we are talking about large numbers of people. By its very nature, air pollution seldom, if ever, affects only a few people at a time. In an area of polluted air, everyone is affected, to one degree or another. Most of the effects are neither seen nor immediately felt, but they are nonetheless real. It may take 20 years, or even more, for emphysema to develop, even among people who live where the air is heavily polluted. This is a real threat to the health of tens of millions of urban dwellers. Furthermore, the numbers of people who already have respiratory disease and who are particularly vulnerable to air pollution are by no means small. I believe Dr. Landau has some figures on this.

Dr. **LANDAU**. Based on data from National Health Survey for the period July 1966 through June 1967, the number of people in the United States with bronchitis, without mention of emphysema, was 3,980,000; emphysema, without mention of bronchitis, 726,000; bronchitis and emphysema, 197,000.

The same National Health Survey estimates that there are 5,380,000 people in the United States who have asthma. This would make more than 10 million people who have respiratory ailments which studies have demonstrated are associated with air pollution.

Mr. **AUERBACH**. May I suggest that we go through that list of questions that you presented in the order we have them. We can come back to any which you want to clarify.

Mr. **CARPENTER**. As a preamble to that let me read a couple of paragraphs from the transcript of January 18, which Mr. Daddario called to my attention as exemplifying his concern. He was talking to Dr. Blomquist.

> What do you see that we used to do in order to be able to come to such a clear understanding about this or to a much clearer one than presently exists so we can eliminate this confusion and have a level of confidence about the criteria established by which people can then move ahead and get support and be willing to act under emergencies as they arise?

Then, on a following page, Mr. Daddario states:

> Wouldn't it have a great deal of effect on what we are willing to pay if we could know that it does have an ill effect at a quicker level than we expect or if we can understand that it does not? If it does in fact aggravate those who already have some kind of an illness, we would then approach it in a different way altogether.

So, if you want to read the questions, then, and your replies, that might carry us on.

Mr. **AUERBACH**. OK. Do you want me to read them? I guess we had better do that.

The first question:

> A variety of data suggests that air pollution is not getting worse from year to year in major cities. These facts indicate that the hazard lies in the air pollution episode when weather conditions magnify normal pollution loads to the atmosphere.

Are present efforts to eliminate episodes showing any promise? Is episode elimination a possible alternative to year round improvements in air quality? Does the hazard in episodes make short term average concentrations more meaningful to standards setting than yearly averages?

Dr. MIDDLETON. You see there are several questions involved.

I guess the first would be, is air pollution getting worse? The answer to this would be that the air pollution problem is really spreading out and thus affecting increasing numbers of people for longer time periods. As the size of the urban areas increase, and as industry builds new facilities in the outlying areas—in other words, with the spreading out of metropolitan areas, the attendant transportation, traffic patterns reach the suburbs so people can work in all these areas—the size of the area affected increases, and in this way the magnitude of the air pollution problem increases.

This is to say that the more people are affected—and moreover they are not affected solely while they are in downtown areas, but also while they are now in residential sections. So the air pollution blanket is spreading out.

As to your question about short-term versus long-term averages, you really need both measurement systems. You need them for different reasons. The long-term averages, which relate to pollution dosage, reflect the chronic exposure to routine levels of pollution.

And the short-term averages show the extent and the frequency of relatively high levels that will affect persons already ill, including not just those with emphysema but also, as Dr. Landau mentioned, the asthmatic patient and others.

Mr. CARPENTER. Would you expect that a locality in setting standards, ambient air standards which would then lead to emission source restrictions, would use both a long- and a short-term criterion?

Dr. MIDDLETON. Well——

Mr. CARPENTER. And are these such that they would lead to roughly the same emission-source restrictions?

Dr. MIDDLETON. Let's be sure we understand that there is a very intimate relationship of short-term exposure to the long-term exposure. They are mathematically related. The average on an annual basis is an integration of all the peaks of the short-term exposures.

So, I would suggest that you can't really separate them, except on the basis of specific effects you may look to.

Would a locality or a State elect to have short-term or long-term numbers as standards? I would think that they may wish to have, for very practical reasons, a standard of ambient air quality that is on a 24-hour basis. Simply for regulatory purposes one needs to know day to day what is happening. This number, I would suggest, would be something that wouldn't be violated more than a certain percent of the time.

I think the same agency would see the wisdom in having a longer term average so they could have their sights fixed on what achievements are being made or what changes are taking place. So also they would have a basis then to see whether they should be concerned about the chronic effects as well.

Mr. CARPENTER. Now in terms of prospective environmental epidemiological research, would your emphasis on the short-term standard allow the researcher to perform experiments and confirm the chosen short-term standard which was adapted from criteria, whereas if we relied only on, say, annual exposures the experimental approach would be so long that we might not be able to do it?

Dr. **Middleton**. That is why I prefaced my remarks by the mathematical association of short term with long. And whereas the relationship varies somewhat from area to area, one has to use ambient air quality data itself.

Mr. **Carpenter**. Yes.

Dr. **Middleton**. This would allow the research worker to project in his experimentation those figures or those numbers that may meet what his particular research needs were.

Mr. **Carpenter**. Well, would you say that it would be worth while before the next step was taken, that is the translation of ambient air standards to emission-source restrictions and perhaps substantial changes in industrial or municipal or personal practices, to conduct confirming experiments at the very point on the concentration-time chart that you chose as your standard, to go in with animals or with human volunteers and to confirm that this was a threshold of response?

Dr. **Middleton**. This confirmation, whether it is laboratory or field, is not so much the question since the documents that relate to criteria contain both.

I think maybe what you are referring to is the fact that in making a diffusion model to relate pollution emissions to the ambient air quality standard, by their geographic location, knowing something about the tonnage being put out, the meteorology of the area, one then can predict what the ground-level concentrations would be from a particular source for a particular period of time, and the air pollution control agency may wish to validate whether in fact this occurs.

That is a different kind of validation, and I would see this would have some merit in getting at emission standards to be determined by local governments, but I don't see the need to validate the earlier question you are talking about.

Mr. **Carpenter**. You would say that restrospective data taken into consideration in publishing the criteria would be adequate, would contain this confirming evidence at the point, at the chosen standard point?

For example, in a concentration-time plot, if you decided on a dose which in fact might not have corresponded actually in time and concentration to some retrospective research on an historical episode or on animal work, your interpolation here would be adequate and you would not perform confirming experiment at that dose?

Dr. **Middleton**. I am really not talking about the confirmation. We are talking about the fact that the several categories of events that take place, that are health effects, are fairly well described as to whether they are chronic or acute, and that we already know something about the dosage, in other words, the time concentration. And regardless of where those will be located you can expect those effects to take place.

So if you are talking about validation and trying to get an integration of chronic and acute——

Mr. **Carpenter**. No, I am not, really. I was just simply talking about where, if you wanted 24-hour standards and, in making up your criteria you had not been able to find any data on a precise 24-hour exposure, or repeated exposures of 24 hours, would you then think that it would be possible and practical to go in and check at 24 hours?

Dr. MIDDLETON. I think what you are asking is a question that we normally take care of in our research needs prior to publishing the criteria, namely, we find out whether these things in fact take place.

Isn't this a part of our——

Dr. LANDAU. Yes.

I think what you may have reference to is the kind of thing planned in London, where, having adopted certain control measures, you now go ahead and measure morbidity in London, illness in London, and see whether or not the control measures have actually had an effect.

Certainly in the United States we would plan an ongoing program to assess the control activity. If the measures we are using are reasonable, there should be some reduction in the morbidity and mortality from these diseases after appropriate control measures have been taken.

Mr. CARPENTER. Well, to be specific if you choose, as New York has done, I believe, 0.1 parts per million sulfur oxide, 24-hour period not to be exceeded 1 percent of the time, would you think it practical and worth while to conduct experiments at precisely that concentration for that period of time to confirm that this was a threshold point of dose response in a properly selected sample of the population?

Dr. MIDDLETON. Your question really is validation of a theoretical assumption?

Mr. CARPENTER. Yes.

Mr. WILLIAMS. Which is not theoretical.

Mr. CARPENTER. Empirical.

Dr. MIDDLETON. OK, empirical.

We are at the point, whether we want to validate that or other things, we are at the point of using mathematical modeling of sulfur oxide emissions from tall stacks to see whether the meteorology, the formulas that have been produced for prediction, are in fact true, and the fact that we do this for some physical measurement is no different than being equally willing to do this for some biological reason.

Mr. AUERBACH. I think what we are basically talking about here is how criteria are set.

The Congress has directed us to develop and publish criteria based on whatever valid scientific evidence exists. We look at that scientific evidence, every bit of it, eliminating what seems to be invalid or inapplicable, and develop criteria based on what the data show about the relationship between levels of pollution, both short term and long term, and the effects that they produce on health, property, plants, and so on; so that the criteria are based on the best available evidence at the time that those criteria are published.

At the same time, we continue our own research, and we continue supporting research by other groups, and when and if that research shows that the criteria we have published should be revised in any way, they can be revised. It may, of course, confirm the criteria down to the last decimal place.

Mr. CARPENTER. But you wouldn't want this revision to occur after some economic or industrial change had been made if you could have run simple tests within a reasonable amount of time to confirm those points before the changes were made?

Mr. Williams. There are no such simple tests.

Mr. Auerbach. That is the whole point.

Mr. Carpenter. That is what I was asking, whether you considered it practical.

Mr. Williams. No.

Mr. Auerbach. No quick and easy ways. It is not likely that research will suddenly produce a whole new set of figures forcing you to change your judgments.

Dr. Steigerwald. Also, I don't think there is any point to verify. We are saying that control to achieve that standard will preclude episodes and will preclude chronic effects because of day-to-day exposure. We are only talking about what happens on 3 days a year, 1 percent of the time.

That control, because of the strong relationship between the average pollution for the year and the peak day of the year, the peak hour of the year, and this 1 percentile point—there is a strong relationship.

We have been looking at this for 10 years, in 10 or 12 cities. We are saying that control to that point will preclude the episode effect and will preclude the chronic effect; so, there really is no point to verify. You can't expose animals to that level of pollution 3 days a year and then not expose them to anything else, because that is not the way people are exposed.

Mr. Carpenter. Let me pursue this once more, because if this point which a municipality would choose from the criteria which you published had a confidence limit on it, as to whether it was one-tenth plus or minus 0.05, that as I understand it might make a substantial difference to the power industry, a difference which all of us would want to know about and to be able to consider.

So perhaps I could ask this question. When a criteria for 24 hours is suggested by your publication, what are the confidence limits likely to be for the guidance of local government?

Dr. Middleton. The confidence that would be involved here is not just a statistical one but the fact that we have exhaustively looked at all the information available. I think you are making a premise that the document might be a flimsy one in the first place. I want to disabuse you of the idea right now. This is a very considerable effort, involving exhaustive study and analysis of the scientific data that are available.

And when we recommend a set of numbers being related for a particular chemical or criterion, dose response, what we say is not going to be said lightly or capriciously. It is going to be based on useful data. If we don't have the useful data, we will see that we get what we think is required.

And when you keep reiterating the need to validate, I read this as meaning that because scientific knowledge is never known at one moment, that we may make some premature decisions. They are premature only in respect to the future, the speculative future. We have to deal with the pollution as it is now.

So if you want to have fiducial limits set for a particular number, this is statistically possible. It is mathematically predictable.

I think when we published our sulfur oxide criteria—and we gave annual averages and we also gave them daily and hourly, and we also gave the range of variability, which is standard treatment.

Mr. Carpenter. And your criteria would also contain a cost factor and a technological feasibility factor?

Dr. Middleton. Not the criteria, themselves, but under the 1967 amendments to the Clean Air Act, criteria for a pollutant will be accompanied by data on the control techniques available to abate sources of that particular pollutant, together with data on the cost of that abatement.

Mr. Carpenter. And you are saying that the difference between one-tenth part per million sulfur oxides and two-tenths percent should not be a contested point, even though that might relate to substantial differences in the cost of achievement?

Dr. Middleton. I am saying if there is clear-cut evidence that a tenth protects the people and two-tenths doesn't, there isn't any contest.

Mr. Carpenter. And you are able to make that clear-cut distinction before you publish the criteria?

Dr. Middleton. If we are not able to make that, we certainly would have expressed it in some range system so that there would be a clear understanding on the part of the reader of the document about the validity of the number.

Mr. Griswold. I heard this number, John described, explained to the Federal Power Commission, under cross-examination by attorneys of the oil and coal industry, and the gas industry, and the one-tenth of 1 percent which you are talking about is the lowest number at which you can find health impairment. It couldn't find it below that because research tools are not sufficiently sensitive.

When you are getting to one-tenth of a part of pollutant at a million parts of air, you are getting down into fine numbers and fine instrumentation. They just hadn't been able to discover any health impairment under that number, at lower levels, but this did not insure that there wasn't health impairment under that level. They couldn't say that, either, under cross-examination.

Mr. Carpenter. But, of course, they have been saying that at 0.015 on an annual average the same judgment held.

Mr. Griswold. Yes.

Mr. Carpenter. So they have measured the much more delicate tenth——

Mr. Griswold. Over a longer period of time.

Mr. Carpenter. Over a longer period of time.

Mr. Griswold. Yes.

Mr. Felton. Continue.

Mr. Carpenter. Irv, why don't you go on with the next question?

Mr. Auerbach. All right. [Reading]:

A common statement is that air pollution is getting worse. Does this mean that there is more contamination in the air over a specific area in a city? or that more areas in more cities are reaching a polluted level? Is there a saturation tendency corresponding to geographical density of industry, buildings and automobiles? For example, can automobile pollution get any worse in the central city?

I think we partly answered that already.

Mr. **Carpenter.** I think you have adequately answered unless you have something you want to add.

Mr. **Griswold.** I would like to expand a little on that, John. This question is asked of witnesses at committees of Congress and Senator Muskie asked it on one occasion.

Now, there is a tendency for air monitoring stations in given regional areas within a metropolitan area to peak out at certain levels under average conditions. And as Dr. Middleton says, the outlying areas tend to build up, but on the short-term basis where the potential for episodes occur you have to take meteorology very much into consideration.

Now, when I say meteorology, I could say a lot of things, but just to put it in context, the air over a large city might be like the Mississippi River down on the delta area. There are stagnant areas where the air doesn't move. There are other parts of the area where the air moves very quickly and rapidly, up to 7 miles an hour, where in the stagnant areas it is just circling around. It isn't being evacuated.

Now, when you have an expanded area with high levels of pollution over it, where the air condition or meteorology tends to maintain stagnant periods in certain areas, the concentrations build higher and higher in those areas.

Follow me?

Mr. **Carpenter.** Yes.

Mr. **Griswold.** In other words, a control officer with the responsibility for 16½ million people isn't worrying about averages, he isn't worrying about a 24-hour peak; he is worried about 14 consecutive days where these stagnant areas build up.

These are the situations under which you have your so-called episodes. And these are what you consider in developing a control program, to see that this doesn't happen, because God help you if this happens and you don't have a pretty good explanation for why you let it happen.

Mr. **Carpenter.** If you have any more on episodes, we might take that at this time.

Mr. **Auerbach.** I think we would like to get an answer in the record on it. That is, is episode elimination a possible alternative to year-round improvements in air quality?

Mr. **Carpenter.** Right.

Dr. **Middleton.** The answer is very simply, "No." I think it is based again on our earlier discussion that you have different effects at these high episodes as contrasted to lower level, long periods of time.

Episodes are to be avoided for the reasons that Mr. Griswold just spoke to you about. But to try and control air pollution simply on an episode basis is not good sense, it is not proper, it is an improper attitude for the Government to assume, it doesn't discharge the Federal responsibility for the protection of the health of people.

Mr. **Felton.** Is there any normal period that an episode will last in different regions of the country?

Dr. **Middleton.** Yes. In Los Angeles there are periods, Mr. Felton, when it is normal for inversions to last for——

Mr. **Griswold.** Fourteen days.

Dr. **Middleton.** Don't you have 253 days a year in Los Angeles when you can expect inversion of 1 to 2 days regularly?

Mr. Griswold. That is right. However, for the most part, and here is another common fallacy, anyone that thinks that concentrations of air pollution of any contaminant being uniform over a whole city is just as wrong as he can be. With 15 air monitoring stations over Los Angeles, over a period of 14 years, with 82 meterological stations, with wind direction and velocity, we could plot wind trajectories in a manner where you could to some degree, not always but some degree, predict exactly when a high level of pollution—if it hit downtown Los Angeles at 10:30 in the morning, it would hit Pasadena at 1:30, it would hit Azusa out in the Pomona Valley at 3:30. While the previous concentrations were falling. This stuff goes in clouds, and follows trajectories and those people that are exposed to these areas, plus the stagnant areas—there are four big stagnant areas over the Los Angeles basin where you do have buildups.

But here again you get into a philosophy of control. In air monitoring, for instance, do you monitor the atmosphere, place your monitoring stations in those areas where you have a normal air condition, what might be considered a norm for the area, in order to determine the effective dose of a control program over a period of time, because control programs take periods of time to implement, or do you establish the air monitoring program to protect the public?

Now, if you want to do it to protect the public, you can put an air monitoring station downwind from a powerplant and you can have that thing going off at scale regularity, you see. I mean talking about what you are talking about, and if you were living downwind, in a prevailing wind direction from a powerplant, and understanding this, you wouldn't want any part of it.

But this one-tenth of a part per million—you talk about the difference between one-tenth and .15, for instance. Why I mean that doesn't mean a thing.

Mr. Carpenter. Is that what you would recommend, that you would put your monitoring station downwind?

Mr. Griswold. You monitor for two reasons: One, you monitor to protect the public, and the second thing is you monitor to find out what is the general situation on a given contaminant, in order to develop an orderly and phased plan to get the whole thing for the entire area down within a tolerable situation.

Mr. Felton. Dr. Middleton, in your testimony, I think you made the statement that the Los Angeles plan was most effective as it applied to industries as opposed to, say, automobile traffic. I think you also said that in major cities automobiles caused 75 percent of the pollution.

Now, what does the State do in a situation like this?

Dr. Middleton. You recognize that the reason that Los Angeles, as an example, has effective control for industries is that industries are a source of pollution that they have the authority to control. It is not that they wish to ignore the motor vehicle. It is the fact that the State in that instance, California, has the control of the motor vehicle.

I think that is the case today across the Nation. The Federal Government has assumed the authority and responsibility for motor vehicle pollution control. The moving source of pollution is to be controlled primarily by emission standards which are invoked across the country.

Now, in those situations, and they are not all on the west coast, they are anywhere across the country, in which the control of the motor vehicle is inadequate to cope with the air pollution buildup, to which the motor vehicle is a significant contributor, we are expecting any organization that comes to us for control program grants to have a plan of action which will deal not only with the industrial source but a plan to take care of mobile sources in an emergency situation.

Mr. **Felton**. What percentage of your effort are you putting into, say, title II of the bill relating to automobiles as opposed to title I?

Dr. **Middleton**. I can supply you some budget figures if you like.

Mr. **Felton**. Offhand, do you know what the ratio is?

Dr. **Middleton**. The effort on stationary sources versus that on motor vehicles?

Mr. **Felton**. Yes.

Mr. **Williams**. I don't think we break it out that way.

Dr. **Middleton**. Ordinarily, we do not. But if the $64 million appropriated for fiscal 1968 for all our activities—including research, enforcement, training, criteria development, and so on—were to be allocated either to motor vehicles or stationary sources, the total for motor vehicles would be approximately $20 million. This is a rough estimate, of course.

Mr. **Carpenter**. I would like to ask concerning your statement that episode avoidance is not a suitable alternative—if studies have been made on the relative cost of a national program that would eliminate episodes and the short-term effects as opposed to a national program that would eliminate the long-term effects, conceding that both effects are damaging to health and that they are different?

Mr. **Williams**. We said, I think, that elimination of episodes is a practical impossibility—impossible as a practical alternative to controlling sources of pollution on a year-round basis. There is no way known to control air pollution in anticipation of episodes.

The data on meteorology, the pipeline we have to God's intent, is not good enough nor going to be good enough for us to ever control air pollution as we see it on that basis.

Dr. **Landau**. I think there may be some confusion with regard to what we are talking about in terms of episodes. If by episodes we clearly mean those unusual situations, such as the Thanksgiving Day episode in New York City, this is one thing. But if you are thinking about pollutant levels which affect asthmatics, for example, these are not the kind of things that take place only during episodes. These are the kinds of effects that take place whenever you get even a fairly moderate increase in the pollutant level.

It doesn't require an episode to cause asthmatic effects, and we are certain it doesn't require episodes to cause effects on bronchitics and persons suffering from emphysema.

What we ordinarily refer to as episodes are real disasters, in which you have excess mortality, usually accompanied by excess morbidity. That is, you have an excess number of persons going to clinics, and so on.

In talking about episodes, you are talking about very high levels as opposed to the fact that during the course of a year you have low values and somewhat elevated levels, but certainly for most areas nothing close to what we call an air pollution episode disaster. You have to have unusual meteorologic conditions to hit this kind of air pollution disaster.

Mr. Williams. It has been suggested many times that we deal with the problem of air pollution mainly by relying on emergency plans which could be put into action whenever a buildup of pollution might occur. Such plans would include, for example, switching from high-sulfur to low-sulfur fuels. This approach was suggested most recently by the American Petroleum Institute, which hired an engineering firm to make a study of its feasibility. The firm's report, issued in May 1967, concluded that the plan would be impractical, principally because of the difficulty of making accurate forecasts of pollution buildups and of administering a system which would require action by hundreds, and, in large cities, thousands, of private facilities on relatively short notice. Furthermore, such a system, even if it would work, would not be a substitute for full-time control of air pollution. This kind of system might, in theory, take care of the worst possible situations, but it would do nothing about the greater threat to human health associated with daily exposure to so-called ordinary levels of pollution in urban communities. An emergency plan is a necessary adjunct to an effective program for achieving and maintaining acceptable air quality in a community, but it clearly is not and cannot be used as a substitute for such a program.

Mr. Auerbach. Your next question [reading]:

> How do you reconcile the difference in physiological response among members of an urban population? Is the air quality which would not affect even the sick or allergic or weakened person a practical goal? Are there alternatives for this portion of the population?

I think this has already been answered, in part.

Dr. Middleton. I will give you the answers I put down here.

Is the air quality which would not affect even the sick or allergic or weakened person a practical goal? Yes. It is quite practical to establish goals to take care of these people.

Mr. Felton. May I interject?

Practical, yes, from a scientific standpoint. I keep having problems, though, with this abatement business, where you go before a court and they have to consider technological and economic considerations. It is going to have to be a very wise court that makes this final judgment. So I do think the "Yes" has to be modified to some degree to take care of the practicalities of implementation.

Dr. Middleton. I don't think we have to modify whether it is a practical goal at all, Mr. Felton. I disagree with you, however I understand your question.

If you are talking about implementation of the goal into a set of local actions where economic and technical feasibility and so forth are involved, that's the area where you need to find out what it is going to cost and whether society is willing to support it. It is a different situation.

Let's be sure we get goals separated from criteria from standards. When you asked the question, "Is it a practical goal?" unequivocally the answer is yes, it is a practical goal. Whether you can attain that by an action program, and have standards and an implementation plan, and is that practical, I have to say I don't know. This has to be evaluated by all the factors involved.

Mr. Felton. OK.

Mr. Carpenter. That is a very good answer.

Mr. **Griswold.** Since Mr. Felton mentioned the abatement actions and I have been deeply involved in all of them because the staff assigned to me has developed the information on them and I am presiding officer at the conferences, I would say there hasn't been a conference yet held where the economics, economic studies, and the testimony didn't show that the cost of pollution was far greater than the cost of control, and this is in the magnitude of 10 times. And this did not even include any health benefits.

All this did was include material benefits, like dry cleaning costs, household costs, and this type of thing. And some of these studies weren't made by anyone that might be considered prejudicial, such as we were. This latest study was made by Ernst & Ernst, a firm entirely apart and under contract to us to bring the facts out.

Here again in the Washington, D.C. study——

Mr. **Felton.** Would you supply some of this material for the record?

Mr. **Carpenter.** I might say they supplied Michelson & Tourin's Washington, D.C. study, which I consider to have a number of internal inconsistencies.

Mr. **Griswold.** Well, it depends. That was the first study that they made, and I would say in viewing that one and one they did for us in New York, where they considered both sulfur oxides and particulate control, that data, in conjunction with other economic studies we made based on studies of two cities in the Ohio River Valley, where there are identical ethnic backgrounds, identical market, identical everything except the degree of pollution in the area, where it came out I think to $245 per family of four; excessive cost, in the polluted city more than the other city, as against the cost of control which ran to a bare fraction of that.

Dr. **Middleton.** If we could revert, Mr. Felton, to the other parts of the same question: Are there alternatives for this portion of the population? We don't have any practical alternatives at this time. We just don't know what to do. But we have a limited number of studies that bear on this issue.

Mr. **Carpenter.** Such as the provision of hospitalization or the alerting of bronchitics?

Dr. **Middleton.** Yes. And can you protect the hospital space that you are going to send them to is a very important part of this. What do you do?

Dr. **Landau.** This protection you are talking about relates only to an emergency situation. But we have to be concerned with the population during this exposure for 20 years or 30 years before people develop either bronchitis or emphysema. So we are very much concerned about the long-term chronic effects, not only about protecting the population during acute episodes—during acute disaster periods.

Dr. **Middleton.** This is the value of the program, you can see, in having the preventive aspects. We are attempting to avoid having episodes. We are attempting to avoid having more emphysema patients. We are attempting to prevent these things from happening. So if we work at the episode level to just chop off the peaks we still have basically this chronic threat to the population.

You need to get the regular, routine levels of air pollution down so we begin to have relief, so we have fewer of this elite population, if you wish to separate them at this point, to contend with in an episode situation.

Another part of the program that we unfortunately don't understand at the moment is what are the differences in pollution levels indoors and outdoors. What is the difference in this room compared to outside on the street?

We just have not had time, money, or facilities to answer this, and it is part of the question of how well can you protect people indoors. We are very poorly prepared to cope with that question. We could just enunciate that we don't have any practical way of doing it.

Mr. AUERBACH. The next question, which I think we fairly well covered [reading]:

> Please discuss the meaning to practical administration of the law of such statements as "air quality that will not harm or offend man, animals, or plants" and "the health of even sensitive or susceptible segments of the population would not be adversely affected."

I believe those statements come from the air quality criteria document. Dr. Middleton has already commented on the meaning of those.

The next question [reading]:

> Odors are considered air pollutants but raise a great problem of value judgment. As Senator Randolph has said, some people are willing to put up with the odor of limburger cheese. Are there instruments which will evaluate odors (not merely detect chemical compounds)? Or odors evaluated by panels of persons? Are criteria for odors contemplated under the Air Quality Act?

The next question also talks about measuring odors.

Mr. FELTON. First of all, are you in the odor business?

Dr. MIDDLETON. Yes. We are getting rid of them.

Mr. WILLIAMS. Everybody doesn't believe it, but—— [Laughter.]

Dr. MIDDLETON. Yes; we consider odors to be air pollutants, not only because they are a nuisance, but also because they have other adverse effects.

We recognize odor as being a serious problem in some places and a nuisance, of course, in many places. There are some cases in which odors are serious enough to be a well-documented health hazard.

We have conducted consultations, a conference, and also recently had a hearing, have we not, Mr. Griswold, on an odor problem in the State of Delaware?

But to the point can we measure odors easily, available instruments to measure odor objectively are very crude. We rely on panels of people. We rely on multiple-choice, three-point validation system.

We are in the process, through several contracts, of establishing the selection of panels and how to use them. These things, I think, emphasize that we do not now have instrumentation to sense odor and make a quantitative evaluation of it.

We do have the capability in a limited way to identify chemical compounds and quantify them. We are now in the process of trying to identify what the chemical compounds are that are specifically associated with an odor factor. So this is the state of our knowledge in this particular field.

Mr. FELTON. In other words, would you say that the common law of nuisance could not take care of the odor problem?

Mr. WILLIAMS. It hasn't.

Dr. MIDDLETON [pointing to Mr. Griswold]. I was thinking of your experience in Los Angeles.

Mr. FELTON. How is your approach going to be different?

Mr. GRISWOLD. If you apply for an injunction under a common law procedure you have a very difficult time in abating it, you see. However, if you have stringent rules in regard to odor where it is adequately described and they are to become law and then are enforced with adequate evidence, you can get through the court.

But in the cases Dr. Middleton is talking about, in two cases I recall on odors—one was the rendering plant at Selbyville, which gave out a strong pungent to a nauseous odor, the medical practitioners in the town testified to the fact that this type of odor was a health impairment because of nausea or vomiting that took place under certain occasions or continued loss of sleep and this type of nervous strain was very difficult for respiratory cardiac patients.

In another one, and this was a little amusing, of a Ticonderoga papermill, New York, affecting Shoreham, Vt., across the lake from Ticonderoga; the odors of these mills, according to businessmen, and particularly to motel and hotel operators, seriously impaired their business, because even honeymooners that stayed there and checked in early in the evening left at 12 or 1 o'clock because they couldn't stand the odor.

Mr. CARPENTER. What was the disposition of that case?

Mr. GRISWOLD. It was to require the International Paper Co. to put on control equipment that would materially reduce or eliminate the odor to a point where it would not occasion a problem in Shoreham, Vt.

Mr. CARPENTER. And that was successfully accomplished?

Mr. GRISWOLD. That has been accomplished, except right now Vermont is complaining again and it is possibly because the mill is running at peak capacity and is overloaded, and they are contemplating building another mill there three times as large.

Dr. MIDDLETON. Mr. Felton asked: "Is the present law system adequate, and how would we approach it differently?"

I think from our comments you may have sensed how we would do it differently, in that we would attempt not to rely on just a public reaction, an adverse public reaction to some smell, an odor, but rather be able to identify this chemically so some law could specifically regard the regulation of that compound, so we wouldn't have to rely on nuisance law, with all its vagueness.

We would say hopefully in our publication of criteria on odors we could identify the odor constituents that are obnoxious and give the measurement techniques for sensing them, and then, by establishing the threshold of sensory perception, establish levels that would be acceptable or not.

Mr. CARPENTER. Would you infer that you would eventually publish a criteria for cadavering, for instance?

Dr. MIDDLETON. I would have to say I don't know what you mean by this. How to dispose of——

Mr. GRISWOLD. Odors from rotting human——

Mr. CARPENTER. One of sulfur-containing amines from rotting meat?

Dr. MIDDLETON. Very well could.

Mr. **Carpenter**. And you would get that specific?

Dr. **Middleton**. I think until we are specific enough to identify the odor factors, we will never be able to specifically enunciate what it is to be cleaned up, except in very vague terms.

Dr. **Steigerwald**. I think hydrogen sulfide is one that we certainly could go after. The current plan is to think about going out after it as a separate pollutant, although it is one of the most common odors.

Dr. **Middleton**. Methyl mercaptan is another one.

Mr. **Felton**. Would you say it is a little lower on your priority list, though, than some of the other items in general?

Dr. **Middleton**. Odor criteria?

Mr. **Felton**. Yes.

Dr. **Middleton**. Yes. I think we indicated our primary emphasis is on criteria for particulates as a class, to be followed almost simultaneously by republication of criteria for sulfur oxides, and from there we would expect to go into carbon monoxide, and then we will give consideration to the others we have mentioned—hydrocarbons, oxides of nitrogen, and oxidants.

Mr. **Carpenter**. Can you be more specific at this time on your timetable for those first three?

Dr. **Middleton**. I plan to have the criteria for particulates and sulfur oxides completed this fiscal year. And I plan to have several air quality control regions designated so that full implementation of the Clean Air Act will begin.

Mr. **Carpenter**. Right.

Dr. **Middleton**. Is that timetable to the point?

Mr. **Carpenter**. Yes, sir.

Mr. **Auerbach**. The next question:

> A Bishop, Md., plant is under HEW orders to end unpleasant odors. The company says it will challenge the constitutionality of the Air Quality Act if the Secretary of HEW seeks a court injunction to enforce the order. On what grounds would the company base its case? What is the HEW legal opinion? Do you know of any other resistant court suits concerning the Clear Air Act as amended?

Dr. **Middleton**. I can read a statement regarding the Bishop Processing Co.'s challenge. [Reading:]

> Presently there is no pending litigation involving the Clean Air Act. In a suit entitled "*Bishop Processing Co. v. Gardner*," the company asked the Federal district court to review its claim, made at the public hearing that the statute was unconstitutional. The Government's motion to dismiss that suit was granted on the grounds that the suit was premature, without mention of the constitutional issue. At this time, any discussion of grounds on which the Bishop Processing Co. may rely in attacking the constitutionality of the Clean Air Act would be speculative and of course, inappropriate. It is the view of this Department that the statute's constitutionality will be upheld.

Mr. **Felton**. Do you know of any State cases involving this same general area?

Dr. **Middleton**. Mr. Griswold, will you reply to that question?

Mr. **Griswold**. The only one was Western Oil & Gas Association, which, in Los Angeles, questioned the constitutionality of rules and regulations limiting the sulfur content of fuel oils burned in various powerplants and other in industry, there. And the net result of that is that they lost all the way up to the State Supreme Court, and then they finally withdrew from that.

Mr. FELTON. Did it have the same factors——

Mr. GRISWOLD. Constitutionality.

Mr. FELTON. Yes, but did the regulation have the same factors such as considering the technical feasibility of it and its economic impact?

Mr. GRISWOLD. Yes.

Mr. CARPENTER. Was it due process?

Mr. GRISWOLD. Well, it was unreasonableness and stuff like this, which requires the burning of oil or of fuels not to exceed one-half of 1 percent sulfur, which practically legislated natural gas, up until this Indonesian oil came in, under the new oil import.

Mr. CARPENTER. Proceed.

Mr. AUERBACH. All right.

The next question, or the next series of questions concerns carbon monoxide: First, what is the evidence that carbon monoxide levels are increasing in the Times Square area?

Dr. MIDDLETON. I don't think we have that specific information, do we?

Mr. AUERBACH. We have not ourselves been conducting measurements in the Times Square area.

Mr. CARPENTER. We will put in the record this quote from Science Magazine, which is the reason for that particular question.

Mr. AUERBACH. Yes, there is a quote.

(The quote referred to follows:)

> Lethal Air Pollution: Warnings of an impending crisis because of carbon monoxide levels in New York City have been issued by two pollution experts. On 26 October New York City's Air Pollution Commissioner, Austin N. Heller, stated that growing carbon monoxide levels may force the banning of cars and trucks during certain hours in some areas of Manhattan such as Times Square. Myron Tribus, the dean of Dartmouth's School of Engineering, recently issued a stronger warning: "We're on our way to a public catastrophe * * *. Carbon monoxide levels in New York City are approaching the lethal level."

Mr. CARPENTER. Yes, but please go on to the remaining questions then, whatever you have prepared.

Mr. AUERBACH. All right. [Reading:]

> Without published criteria on carbon monoxide, how can "lethal levels" be judged?

Mr. CARPENTER. May I interject here a reference to this table, table 4 in the Department of Commerce report, the "Automobile and Air Pollution," part 2, page 16, which was also submitted, I believe, in a similar form to Senator Muskie, last year, which indicates that in New York, Chicago, and Cincinnati, where measurements have been made in 2 consecutive years, the values for 1967 are less than those for 1966 in a majority of instances.

I am unable to comment on the statistical significance of these, but they do suggest questions that we are asking about saturation with respect to automobile density, the problems raised by this article quoted from Science Magazine, and the concept that in California and now in the Nation we are establishing emission-source restrictions without the benefit of published Federal criteria.

You provided as an answer to Mr. Daddario's final question a résumé of the California situation which indicates that their standards are 30 parts per million for the level mid-8-hour period, called serious

8-hour exposure, and 120 parts per million for 1 hour exposure, and I would appreciate your contrasting these figures with the industrial hygiene standards of 100 parts per million——

Dr. **Landau.** No, they are now 50, aren't they?

Mr. **Carpenter.** The latest information I have is contained in "Industrial Hygiene and Toxicology," volume 2, 1962.

Dr. **Landau.** I think the tentative threshold limit value is now 50 parts per million, but we can check that.

Mr. **Carpenter.** Yes, if you would.

And in this table, in this particular volume, the indication is that a concentration inhaled for 1 hour without appreciable effect is 400 to 500 parts per million.

Dr. **Landau.** Yes. On this 50 parts per million, we can read from the testimony that was submitted to the Muskie hearing. It says:

> Fifty parts per million is now recommended as the upper limit of safety for health in industrial workers exposed for an 8-hour period.

So that 100 parts per million has now been reduced to 50 parts per million.

Mr. **Carpenter.** Whereas, these measurements taken in traffic rarely exceed that, although of course, they do in some cases. But the general question is the—what should be the layman's reaction to this emission-source restriction at this point before criteria have been published?

Dr. **Middleton.** First of all, let me say that the carbon monoxide levels in the Los Angeles area, for example, are going up about 5 percent per year, which is just about the increase in motor vehicle population.

Mr. **Carpenter.** Excuse me. Would that be at, say, 6th and Spring?

Mr. **Griswold.** It is the downtown area.

Mr. **Carpenter.** But it would not be at any one point?

Dr. **Middleton.** Concentration downtown would go up some, but the total tons of carbon monoxide in the whole area is increased because the total motor vehicle population is increasing.

Mr. **Carpenter.** Well, excuse me again, but if I could call attention to figure 12, on page 21, of this document, which is a moving 12-month average, could you comment on that chart, the dotted line being carbon monoxide, indicating a decrease in the last year?

Dr. **Steigerwald.** If you are looking at, say, average monthly temperature variations from year to year or average rainfall or average wind speed, these have great variations.

Mr. **Carpenter.** And there are cycles longer than a year.

Dr. **Steigerwald.** Yes. There is no possible way to take a 2- or 3- or even a 4-year period. And if you ignore meteorology and depend only upon concentration, you cannot draw any conclusion.

Dr. **Middleton.** May I also point out in reference to figure 12, that the period 1961 was lower than 1960.

It is difficult to read on the graph—it would appear to be a significant drop, but since it is an annual drop I think it emphasizes what Dr. Steigerwald has just said.

Mr. **Carpenter.** They are moving 12-month averages.

There are points on that curve for each month, but they have shifted the 12-month average, you see, in plotting it.

I assume that you are inferring that all of this variation is due to meteorology and that there is a long-term increase in the local concentration of carbon monoxide?

Dr. Middleton. That's correct.

Mr. Carpenter. And you have——

Dr. Middleton. You perhaps have a better expression of the meteorological effect in figure 12 on nitrogen oxides, in the fact that you see shifts in its sources. Now let's be certain we also understand that changes in levels, even though they are moving averages, are often due to the change in location of the monitoring station, so that when one looks at the data one must not make the immediate assumption that the change is real in the sense of the ambient air level concentration in the region.

Dr. Steigerwald. The other point is that carbon monoxide, coming from the automobile almost exclusively and coming at high concentrations at the exhaust pipe, with a great decrease in concentration as you move away, is very sensitive to many things. And if in 1965 they happened to open a new freeway that took a good share of the traffic off the street in front of that sampling station, you would see drastic differences.

Mr. Carpenter. Yes.

Dr. Steigerwald. At that one sampling spot.

Mr. Carpenter. My question then would be: Does the national center have data that rigorously affirm that local concentrations of carbon monoxide are, in fact, increasing, and that there is not a saturation of automobiles per city block, and so on, which prevents any increase?

Do you have such data and could you guide us to it?

Dr. Landau. If you are thinking in terms of a specific street, it is very likely that there are certain streets that can take no more traffic. On the other hand, if you think in terms of the background levels of carbon monoxide, this means that people who live adjacent or fairly close to the freeways will be subjected to values which will be lower than those on the freeways. But they also will be getting background values from the areas right around the congested streets.

So the background levels are tending to build up even though the levels of carbon monoxide directly adjacent to the freeways just can't increase any more because you have a very restricted area, unless you have a highly unusual meteorological condition.

So, it is true, I suspect, that given areas can't handle any more cars and that the level of carbon monoxide really has kind of a ceiling, unless you have an unusual meterologic condition. But the background values can increase.

Mr. Felton. This is the same as the comments regarding the suburban level?

Dr. Landau. That's right. It is going from the city and spreads out. So you have much more of an equalization, I would say. So the higher values tend to spread out even though there may not be any real increase in the carbon monoxide in a given block just off the freeway.

Dr. Steigerwald. We now have done this in a random model, and have underway more sophisticated models that try to take meteorology and figures of traffic density in each square mile of the city in attempts to relate these two into ground-level concentrations at different points in that city, say in the year 1985, as an attempt to look ahead at how bad will carbon monoxide be at ground level in that city, grid by grid, square mile by square mile, 15 years from now. This is being used in an attempt to compute back to what sort of standards do we need now at the tailpipe, to say, preclude hazardous situations 15 years from now.

Dr. **Landau.** I think what we are saying is that, taking the population as a whole, there is a greater residential exposure as you have more cars, so that the population not only directly adjacent to the freeway but a little farther away and farther and farther away from the freeway is being exposed to increasingly elevated levels of carbon monoxide as the numbers of cars and car usage increase within the city.

Mr. **Carpenter.** Increasingly elevated, but far lower than these values reported in the National In-Car Test?

Dr. **Landau.** Yes. I think these background values—the residential exposure would have to be lower than these in-car values pretty much by definition. I would like to quote a statement from the Swedish Medical Air Quality Guides, which may have some relevance. It says:

> It is to be expected that persons especially sensitive to anoxia, those suffering from diseases of the heart and lungs, for example, are also sensitive to exposure to low concentrations of carbon monoxide.

Then it says:

> With respect to the effect mechanism of carbon monoxide, it may be questioned whether any threshold value exists for persons sensitive to anoxia. In any case, no investigations have been carried out which show where such a threshold level is to be set.

I think what we are saying, then, is that we cannot accept an industrial standard for the general population. Further, we are not certain, as the Swedish experience indicates, we are not certain as to what is the proper level for persons who have deficiencies, certain kinds of deficiency in the terms of the oxygen-carrying capacities of the blood, to be able to make a judgment as to what threshold level is at which these people will be affected.

Certainly there is every indication that this level will have to be substantially lower than the accepted industrial levels and certainly, probably very definitely, lower than the levels that would be found in cars.

Mr. **Auerbach.** Dick, do you have further questions on carbon monoxide?

Mr. **Carpenter.** Yes, I do, and they are related not to carbon monoxide per se but to the question which Mr. Daddario asked. Dr. Middleton answered to the effect that the rapid promulgation of exhaust emission restrictions was not going on in the dark, that you were following the lead of California, which had, in fact, followed this same sequential process of criteria to standards to emission controls.

My question is related to that answer, in which I have been unable to ascertain as yet how California did arrive at the progressive reduction of carbon monoxide to these 30 and 120 parts per million standards.

Dr. **Middleton.** Let me just generally say that the emission standards for motor vehicles in California were reached based on the belief that air quality in the early 1940's was satisfactory. And projections then were made from later motor vehicle levels, this was in 1959, I believe. I will ask Mr. Griswold to give you more details since he was involved in this.

Based on the population at that later time and the existing levels of carbon monoxide, projections then were made back to the period when carbon monoxide was believed not to be a factor, nor eye irritation to be a factor.

Mr. **Carpenter.** What was the factor in carbon monoxide effect? This is what I haven't been able to ascertain.

Dr. **Middleton.** You mean the adverse effect?

Mr. **Carpenter.** They have no adverse effect.

Dr. **Middleton.** Well, adverse, in this sense, as damage to plants and destruction of property or impairment of visibility.

Mr. **Carpenter.** Carbon monoxide does damage plants?

Dr. **Middleton.** No, it doesn't damage plants. I am saying the word "adverse"—

Mr. **Carpenter.** So it is not applicable to carbon monoxide?

Dr. **Middleton.** It was believed not applicable to carbon monoxide, because it had no physiological function at that level. We are mixed up now in using California's terms of three categories as contrasted to one criteria.

Mr. **Carpenter.** Their footnote, which I would assume is essentially their criterion here, says:

> Given certain assumptions concerning ventilatory rates, acute sickness might result from a carbon monoxide level of 240 parts per million for 1 hour in sensitive groups because of inactivation of 10 percent of the body's hemoglobin. In any event, it is clear that when a population exposure limit has been set for carbon monoxide, because of exposures from other sources, community pollution standards should be based on some fraction of this limit.

So I assume they took this 240 acute response in sensitive groups, divided it by two for their 1 hour exposure, and by eight for their 8-hour exposure, to get this fraction of safety?

Dr. **Middleton.** I would have to do an awful lot of recalling to get the old numbers back.

Mr. **Griswold.** You recall, John, when we were all discussing the criteria out there, and also the motor vehicle standards? There were two major theories involved: One was the rollback theory, the one Dr. Middleton mentioned, to an air quality existent prior to popular reaction in the early 1940's. So a calculation was made based on 1956 or 1957 vehicles of how much carbon monoxide was being put out by those vehicles registered and operating in 1940.

Mr. **Carpenter.** Just as a tonnage.

Mr. **Griswold.** On a total tonnage basis. Then the degree of control required by California in its original motor vehicle emission standards for carbon monoxide was related to that percentage of control that would result in the estimated number of motor vehicles registered in 1970, not putting out any greater tonnage of carbon monoxide than those that were registered in the early 1940's.

That was true on hydrocarbons, too. However, in the meantime, the State Department of Health was developing these standards and realistically it seemed that in the calculations which resulted in the standards which you have just read—they fitted in beautifully with the 1940 rollback system.

Remember, these were some of the first standards that were developed. It was recognized that not all of the knowledge was in, but their basic philosophy in the developing standards was to get a consensus of what the standards should be based on medical knowledge extant, to amend them as new knowledge became available, and also to pinpoint that or those areas where there hadn't been enough research done.

Mr. **Carpenter**. And the Federal Government then has followed the California emission restrictions without particular regard to whether the rollback theory, or a stringent health criterion was the source of those standards?

Dr. **Middleton**. This is what is being refined now for the purpose of producing the criteria that will be published in the next fiscal year.

Mr. **Carpenter**. For hydrocarbons and for carbon monoxide?

Dr. **Middleton**. Carbon monoxide will come sooner.

We have learned enough about what carbon monoxide does to people to be much more concerned with the health effect than just the rollback. We understand that the smoker is much more prone to the adverse health effects of carbon monoxide because he has already laden himself with carbon monoxide. So the smoking population is a more vulnerable population.

We also have learned more not only about the carboxyhemoglobins, but also about motor effects.

Perhaps, Dr. Landau could elaborate just a bit on this.

Dr. **Landau**. There is increasing evidence now becoming available about the effects of relatively low levels of carbon monoxide. They have an effect on psychomotor performance. They have an effect on people's ability to discriminate time and visual stimuli effectively.

These are things which are very important from the standpoint of driver efficiency. That is, if carbon monoxide at the levels which people are being exposed to in cars is that level which in our laboratory experience indicates that people do have deficiencies in judgment, that they do make mistakes in judgment much more often, that they have much more difficulty in reaction times, in terms of what we call intelligence perception—this, then, clearly is of significance to us.

Mr. **Carpenter**. Would you infer from that, that cigarette smoking should be considered in issuing drivers' licenses?

Dr. **Landau**. Realistically, I don't see how you can. I think in principle that probably would be a good point.

(A short recess was taken.)

Mr. **Felton**. Dick, there are still a lot of questions here. Take the ones that you really want.

Dr. **Landau**. We will have to get you some data on New York City's measurements of carbon monoxide particularly during the 1966 Thanksgiving Day episode, when the levels were relatively high.

(The data referred to follows:)

At the Central Laboratory Station, located on East 121 Street in Manhattan, hourly carbon monoxide values on November 24, 1966, were as much as 7½ times the hourly average value for corresponding time periods during the rest of the month.

Mr. **Carpenter**. Let's get to this one, then—I will have just two more.

In real life, polluants occur together rather than singly and effects are changed due to weather, smoking, infectious agents, et cetera. What is the likely magnitude of error in cost-benefit judgments for standard selection when criteria are established only for each pollutant alone? Does the large number of possible combinations rule out criteria establishment for complex atmospheres?

Dr. MIDDLETON. That is fairly easy to answer. It is easy to answer in the sense that you are probably less likely to make errors for single pollutants based on the fact that they are acting in concert, since synergistic or enhancement effects are likely to mean that the numbers should be smaller than the criteria will be for the single pollutants.

Let me illustrate the case——

Mr. FELTON. In which way?

Dr. MIDDLETON. In the way that an ozone level that causes damage to tobacco is a very different number and much smaller when sulfur dioxide is also present. Five times less ozone is required to produce the same effect, and sulfur oxide in neither instance causes any effect.

Mr. FELTON. So that, if you issued criteria for ozone alone you might, in fact, err?

Dr. MIDDLETON. We might not be protecting the public as well as we should.

Mr. WILLIAMS. Yes.

Mr. CARPENTER. Then how do you propose to deal with these possible synergistic effects?

Dr. MIDDLETON. By trying to get the knowledge that shows what is happening in synergistic systems. Until we know something about the synergistic effects, we are obliged to use the best scientific knowledge that is available for the individual pollutants.

Mr. CARPENTER. Do you put a safety factor in?

Dr. MIDDLETON. No; our criteria are statements of fact. Let's make that clear: Criteria are expressions of effects that occur for a given dose.

Mr. CARPENTER. Would you recommend that a State using your criteria to set standards use a safety factor because of a lack of knowledge of synergism?

Dr. MIDDLETON. That certainly ought to be considered whenever standards are set. If an adverse health effect, to give you an example, is caused by a tenth of a part per million of something—that is the minimum threshold effect—and half that, 0.05 parts per million of the same pollutant causes agricultural damage of economic concern——

Mr. CARPENTER. You choose that.

Dr. MIDDLETON (continuing). Then you choose that to assure that at least you are not going to hurt people and you may even get the support of farmers in cleaning up the air to help their own economic interests.

These are the kind of things that have to be done at the local level.

Mr. CARPENTER. Now the other question I had——

Dr. MIDDLETON. Excuse me a minute. I want to ask if Dr. Landau can give us an example of synergistic action that affects people?

Dr. LANDAU. The most common one is the combination of particulate matter and sulfur oxides.

The Russians have taken this into account. They have standards for individual pollutants, 96 of those currently, but they also have standards for combinations, including combinations where there are synergistic or interacting effects.

Each of those is reduced in some proportion so you get something less than the standard for the individual pollutants you started out with. So this problem is not unique, you see, to American experience.

Mr. Carpenter. Then, the answer to my question is that the large number of possible combinations does rule out criteria establishment for complex atmospheres?

Mr. Williams. No.

Mr. Auerbach. Are you talking about a single criterion for air pollution?

Mr. Carpenter. Or for two. For sulfur oxide and particulates, to be specific.

Would you contemplate issuing a criteria for those two in combination?

Dr. Middleton. I guess I am having difficulty understanding what the real point of the question is.

It would have to be a third-party system. Where you had particulates and sulfur oxide interacting and certain concentrations having effect, you would have a variable number, depending upon relative proportions.

Mr. Carpenter. It would be like this oxidant chart on page 8 of the Commerce publication.

Dr. Middleton. Well, if we knew that the enhancement or synergistic effect took place in a physical-chemical way as this, it could be predicted. We don't know that now. The size of the particles is very important, but we are uncertain whether the nature of the particle is important. Present indications are that maybe the nature of the surface of the particle is less important than its size. We simply don't have enough information at this time to put together this kind of a synergistic criteria system.

Mr. Carpenter. OK. That answers my question. The last one, and one I am particularly interested in:

> Are our planned efforts and expenditures in air pollution control being subjected anywhere in government to a comparison with other alternatives to increase the general health of the public?

Dr. Middleton. The Congress has clearly established the fact that it is concerned about air pollution and it has set some goals. The new amendments to the Clean Air Act, for example, call for some specific missions to be performed.

The fact that we have appropriations and funds seems to me to have uniquely and explicitly described the extent to which we do need to expand at least this effort to cope directly with the air pollution problem.

As to trade-offs, you will recognize that we have a specific request in the Clean Air Act that addresses itself to the cost of air pollution, in the order of cost-effectiveness studies and the like.

And, we have a number of contracts that are beginning to be set in motion that relate to this question.

So I answer you in the sense that we have a mandate to clean up the air with a law that says how we would like it done, and we are pursuing that, and the larger nature of the question you described is a matter of departmental concern here.

The Department is pursuing it in its adjunct activities as a separate operation. But the cost-effectiveness system that you speak of—we have already begun some work with the Council of Economic Advisers, and I am sure we will have more.

Dr. **Steigerwald.** We are actively trying to find the cheapest way to solve the air pollution problem. We are doing a number of cost-effectiveness studies of alternative control schemes, and so on.

The bigger question of how do you relate money spent for air pollution or for noise control or for crime in the streets is not our mandate.

Mr. **Williams.** I would say that that answer to that question is provided largely by the Congress of the United States, which decides which bills it will pass and which it won't, and what kind of appropriations it will allow. In addition, you have, of course, the Bureau of the Budget, the Office of Science and Technology, and the Council of Economic Advisers in the executive branch trying to make these decisions.

Ultimately, I think the public is making these decisions. The public, I think, has evidently convinced virtually all Congressmen in both Houses that it would like to see a lowering of air pollution, and so we are given this job to do.

Mr. **Felton.** Gentlemen, we thank you. I think this meeting has been very helpful.

(Whereupon, at 4:20 p.m., the committee was adjourned, subject to call of the Chair.)

Staff Meetings on Environmental Quality

FRIDAY, FEBRUARY 23, 1968

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT,
Washington, D.C.

Mr. Joseph M. Felton, counsel for the committee, and Mr. Richard Carpenter, Legislative Reference Service, Library of Congress, met with Mr. Joe G. Moore, Jr., Commissioner, Federal Water Pollution Control Administration, and other officials of the Department of the Interior, in room 4421, Main Interior Building, Washington, D.C., at 1 p.m. Accompanying Mr. Moore were Mr. John T. Barnhill, Deputy Commissioner, Dr. Leon W. Weinberger, Assistant Commissioner, Research and Development, and Dr. Allan Hirsch, Assistant Commissioner, Program Plans and Development.

Mr. FELTON. Gentlemen, we do thank you for meeting with us. As we mentioned earlier, Mr. Daddario suggested that it might expedite matters if we meet informally and discussed these questions rather than submit formal questions for the record.

Dick, would you like to start right in with the questions?

Mr. CARPENTER. Yes. As you recall, Mr. Ryan was very interested in the problem on the Hudson River and the approval of the percentage of treatment as contrasted with some statements which had been made on the normal degree of treatment which the FWPCA would expect.

Question No. 1 suggests that the New York City sewage treatment plant is reported to remove 70 percent of the organic waste. How is this figure justified? What is the relationship to the quality of the Hudson River water? What difference in water quality would have resulted from 90 percent removal? Or 60 percent?

A similar situation has been reported to us in the Raritan Bay, where they have a 70-percent treatment, and if they could extend their outfall further in the estuary, further out, they have calculated that this would be equivalent to 90-percent treatment as far as their receiving water is concerned.

There was some question as to whether they should raise this issue of the alternative of increasing their treatment or moving the outfall because it might mean that Federal funds would be withheld unless they went to the higher treatment.

So my question concerns the way in which you make these judgments of the percent removal as how they are related to the actual use of the receiving waters.

Mr. MOORE. Yes. Let me make a general comment. Others here may want to speak to it. But let me make a general comment about the one on the Hudson River. I am not acquainted with the Raritan River case. But in the case of the design of this Hudson River plant, the plant is designed as I recall to meet its maximum capacity in the year 2010. As a matter of fact, if you design one to meet an increasing capacity, then initially it will achieve a higher percentage removal at less capacity than that for which it is designed, then it ultimately will remove at the capacity for which it is designed.

In the case of the Hudson River plant also, the city of New York has acquired some 22 acres upon which to construct that particular plant. And it has plans to acquire additional land to expand this facility. So that you have both a combination of a plant that is designed to take a large capacity than that which it will initially take, which means you get a higher percentage removal to begin with than ultimately, and also during the course of the increase of the inflow to the plant, normal increase for which it is designed, there will also be additional time to acquire more land.

As I recall, there are some 4 acres or in that range that they propose to acquire in addition to the 22 acres they already have.

Now what you are faced with is the question of whether or not you let them proceed with a plant designed for a capacity to be reached in 2010 and achieve some removal—I think John can give you the percentages—of BOD at this point in time or whether you wait until you get the entire situation in hand so you can move to get a higher degree of removal. In other words, you are faced with the question of staging of construction in order to get some improvement now.

Mr. CARPENTER. Were available funds a part of this staging?

Mr. MOORE. Funds could be considered a part of the staging, but it is a question of getting some construction underway now, on land that is available for a plant that was designed 3 years ago, as opposed to the alternative, for example, perhaps, of waiting until they acquire enough land which could take some years or one other alternative that has been internally discussed is the location of the plant somewhere else in which case you would have to start over with land acquisition for a new site. As I understand it, it has taken them some 20 years to acquire the 22 acres they do have upon which to construct this plant.

Mr. CARPENTER. And at the present time raw sewage is going into the river?

Mr. MOORE. Is going into the Hudson River. It is a difficult decision, you see, whether you move to make some immediate improvement in the quality of the discharge or whether you wait until every possible ideal situation has been developed, and then you move at that point in time. There is nothing inconsistent in terms of the objective of water quality in the Hudson River—there is nothing inconsistent with beginning now for the construction of the facilities that will achieve the degree of removal that is contemplated in the design of this particular plant.

Mr. CARPENTER. Which would be 70 percent.

Mr. MOORE. Mr. John Barnhill can give you, I think, those percentages.

Mr. BARNHILL. Well, the present plant is designed at capacity.

Mr. MOORE. In 2010.

Mr. BARNHILL. To remove 53 percent of the BOD, but as Mr. Moore said in the first few years of its operation it will remove about 70 percent of the BOD.

Mr. **Carpenter.** This is due to the holding time, the capacity to hold the sewage to allow the biological process?

Mr. **Barnhill.** Essentially that is correct, but it goes back to this problem of available space at the present time. The 22 acres is only large enough at this time for them to be able to construct what we call a full primary treatment facility.

Mr. **Carpenter.** That removes the floating, suspended, and settleable material?

Mr. **Barnhill.** That is correct. And a modified activated sludge process, as a secondary treatment.

Mr. **Carpenter.** What will be the initial percent removal, then?

Mr. **Barnhill.** Seventy percent.

Now the city, since this plant was designed, has acquired an additional 2.8 acres of land on which they propose to extend the secondary treatment facilities. When this work is completed at design capacity, it will remove 70 percent of the BOD. Again in the initial years of the expanded facility it will go higher than that..

Mr. **Carpenter.** Tell me what percent of the BOD of the raw sewage is removed by the primary treatment alone?

Mr. **Barnhill.** Normally that will run, depending on the individual sewage, 40 to 60 percent removal BOD.

Mr. **Carpenter.** And the secondary treatment then adds another 10 percent, with the capacity which they will have?

Mr. **Barnhill.** Well, it adds another 10 to 30 percent, depending on what you achieve in the primary treatment.

Mr. **Felton.** When will the secondary treatment be completed?

Mr. **Barnhill.** You mean the extended treatment works?

Mr. **Felton.** Yes.

Mr. **Barnhill.** I don't know.

This, of course, has to deal with what they have to clear off, the 2.8 acres they have acquired and so forth.

Mr. **Felton.** Is it just a question of building it? In other words, do they plan to start in 1975, or is it just a question of how soon they can build it?

Mr. **Barnhill.** Well, I think it is a question of how soon they proceed to build it. I don't believe they have designed the additions to the secondary treatment facilities yet. It is my understanding they have only recently acquired this 2.8 acres.

Now the city has also initiated administrative procedures to acquire another 4.9 acres on which they propose to further extend the secondary treatment facilities. This will provide them with enough facilities to remove 90 percent of the BOD at design capacity. This will meet the water quality standards requirements and enforcement conference recommendations that the Secretary made.

Mr. **Moore.** I think—if I may interrupt at this point—that this is important, that this is a staged construction process. It would be staged in any event. That is, the normal procedure to construct first a primary plant, and then a secondary plant—then the secondary plant extension, so to speak. It is also important, I think, to understand the significance of this land acquisition question. With 22 acres available now and then 2.8 that has been acquired since this plant was designed, and then the process for acquiring another 4.9 acres, you would then have a plant that would remove 90 percent of the BOD.

Mr. Carpenter. So there is nothing inconsistent in your approval and release of Federal funds at this point in time because you expect to continue to insist on this eventual 90-percent figure?

Mr. Moore. Yes.

Mr. Felton. You don't have a date on that yet, do you?

Mr. Barnhill. Well, let me say this——

Mr. Moore. Tell them how long it would take to construct a plant on the 22 acres; in other words, give them some idea of what the construction schedule would likely be for a plant of this size.

Mr. Barnhill. Well for a plant of this size, and it is being designed for 300 million gallons per day capacity, it would normally take 2 years to build a plant of this size. So it should be in operation sometime in 1970.

Mr. Felton. How long would it normally take to build the first addition to the secondary treatment?

Mr. Barnhill. Well, I would say the design and construction of the extended secondary facilities would again perhaps take 2 years, for design and construction both.

Mr. Moore. Actually the design of it could continue while the——

Mr. Barnhill. Yes; the design could be going on while this initial plant is being constructed.

Mr. Felton. Right. Now that would raise the 70 up to how much?

Mr. Barnhill. Well, I could only make a guess, but I would say it could probably—in the initial years of operation it would approach 80 percent.

Mr. Felton. And then the second stage of the additional facilities for secondary treatment—this has to go through the condemnation process and all.

Mr. Barnhill. Clearing the site.

Mr. Felton. Which I would think could probably be completed in 5 years, I am talking about in 1972. So again it would be about 1975—or would something like this normally take longer?

Mr. Barnhill. I think that depends on a lot of things. You can get tied up pretty badly in condemnation proceedings.

Mr. Moore. But it would also depend—in some cases you can have condemnation proceedings underway and you can actually go ahead and use the land for a public purpose while the litigation is being concluded. I don't know whether this is true in New York or not. But that might not necessarily be a long-term delay. It would just depend on the individual circumstances.

Mr. Felton. In other words, something like 1975 would be a ballpark figure?

Mr. Barnhill. I would hope so.

Mr. Moore. If everything clicked.

Mr. Barnhill. Now I think it is important to recognize that this present plant, the one that will produce 70 percent BOD removal, was designed prior to the requirement of our quality standards and prior to the Secretary's recommendations as a result of the enforcement conference up there.

Mr. Carpenter. Which were 90 percent.

Mr. Barnhill. Which were 80 percent at all times, or such other degree of treatment as the State of New York required to meet water quality standards, approved by the Secretary.

Now the enforcement recommendations and the water quality standards both give the city of New York until 1972 to comply both with the standards requirements and enforcement recommendations. You see, this is the reason why we feel that this kind of phased construction is quite adequate for our purposes. I think it would be quite unfair to the city of New York for the Federal Government to say, "We will not make a Federal construction grant at this time because you have not designed a plant that will remove 90 percent BOD in accordance with the water quality standards."

Mr. FELTON. I don't understand. You are requiring 90 percent by 1972?

Mr. BARNHILL. Well, we are requiring 80 percent at all times, which means the plant would have to be designed at 90-percent efficiency in order to guarantee.

Mr. FELTON. I thought you just said that you didn't expect this second additional facility to be completed until about 1975.

Mr. BARNHILL. I didn't say that. That was our guess, and I said I would hope so. I said I would hope so.

Mr. FELTON. You would hope actually by 1972 to meet the requirements?

Mr. BARNHILL. Well, as far as we are concerned, the time requirements on the water quality standards and the enforcement recommendations still hold. They are still going to try to get the city of New York to meet this commitment by 1972. They have not been relieved of this responsibility. And it has been agreed that the city, the State, and the Federal Water Pollution Control Administration will meet at 6-month intervals to discuss what progress has been made.

Mr. MOORE. Let me say almost any alternative you can mention would certainly almost have to extend the time beyond 1972.

Mr. BARNHILL. Yes. And there would be, I believe, a tremendous increase in cost for any new site and new construction. It has been reported that construction rates in that part of the country are going up an average of 8 percent. I think that might be a little high. But even if it is only 6 percent, 6 percent per year for a $190 million project represents an awful lot of Federal, State, and local funds. So if this project were put off for 5 or 6 or 7 years, which could certainly happen, the cost increase would be very substantial. To relocate it, of course, would mean construction of substantially more intercepting sewer to convey the waste to the new site—I don't know where the relocation site would be. And in this project, just to give you an example, the existing intercepter sewer construction is costing roughly $90 million.

Mr. CARPENTER. Is there any storm sewage going through this new plant?

Mr. BARNHILL. Well, I would assume there is.

Mr. CARPENTER. There is some combined storm and sanitary sewer?

Mr. BARNHILL. I really don't know, but I would have to guess, New York City being as old as it is and being Manhattan Island, that it is practically all combined sewers.

Mr. CARPENTER. And that might be the time when your 90 percent would degrade to 80, when you were bypassing—or are you referring to the 80 just meaning a portion of the time when you had to shut down a certain tank or for repairs? What is the relationship, again, of your 90-percent design to assure 80-percent overall treatment? Does it have to do with storms?

Mr. **Barnhill.** Well, it might have to do with storms, but it might have to do with emergencies in the plant.

Mr. **Carpenter.** Yes.

Mr. **Barnhill.** There are times when the character of the sewage changes and so forth.

Mr. **Carpenter.** Now, I would like to use this example of your administrative action to help illustrate the sequence of selecting water quality standards and associated abatement technology that one would install.

As we heard from Dr. Weinberger in the hearings, the first consideration would have been the use of the Lower Hudson River, not only the present use but what you might anticipate as future desirable uses, from which you would have examined the criteria corresponding to those uses, these criteria including the residual BOD, perhaps nutrients and so on.

But could you tell us the sequence that you follow to arrive at this 90-percent treatment and how you would—I believe you mentioned that this plant would be 53 percent, at its 2010 capacity——

Mr. **Moore.** On the 22 acres.

Mr. **Barnhill.** The present.

Mr. **Carpenter.** So unless more land is acquired as we go along, this percent removal will degrade to 53 percent?

Mr. **Barnhill.** Yes.

Mr. **Carpenter.** Just due to the volume which has to be passed through a limited plant site?

Mr. **Moore.** Yes, sir; that is correct.

Mr. **Carpenter.** Well, could you——

Dr. **Weinberger.** Could I add something to that? I think that one must recognize also that in the intervening period there is very little question but what we are going to be able to perhaps modify the existing treatment at existing sites and obtain increased treatment.

Mr. **Moore.** By modify, you mean improve?

Dr. **Weinberger.** Improve, yes. So we can operate these plants so we do remove more of the impurities. So I think during this period that the plant is coming up to design capacity—and you do have to seek alternate solutions, one of which is perhaps going to be treating the wastes elsewhere. We should not write off the idea that at a particular site, with changing economics, we can perhaps put in a more expensive type of treatment. Some of these are not available now, but we are talking of 40 years in the future.

Mr. **Carpenter.** Right. This would suggest that there would be ample opportunity through research, development, if you will, to come up with improved treatment within the constraints of a particular site.

Now what will the citizens of New York get for their money in installing this plant?

Mr. **Moore.** Higher quality of water in the Hudson River.

Mr. **Carpenter.** With respect to what uses?

Mr. **Felton.** To put it another way: You can't swim in it even though it may not be polluted, you still couldn't swim in that type of situation?

Mr. **Moore.** I think the point that needs to be made is—and I personally feel rather strongly on this point—the ultimate has to be complete treatment. There is no alternative to this. But the point I think that is important is that you don't get from raw sewage to full secondary treatment just by constructing the facility. It is extremely important that the facilities be properly operated. This is like driving an automobile. Most of us drive one that is probably not operating at its optimum efficiency. If you were to take it into a crew of racing experts, they would probably do all kinds of things to it to make it operate at its optimum efficiency. And one of the things that has to be done in the course of time is to assure that the plants are operated at their designed capacity, if you want to think of it that way. But what they get is merely a third-hand car working up to one that will operate at optimum efficiency when the time comes. But you have to begin with the primary treatment process, where you don't have it. You have to go on to the secondary process of treatment beyond the primary treatment before you achieve what it is that you are after.

Mr. **Felton.** But is this raw sewage the primary cause of pollution in the Hudson River?

Mr. **Moore.** Dr. Hirsch will have to answer that. I don't know the primary cause.

Dr. **Hirsch.** I am afraid I would have to say that I don't know the primary cause either, but I think of the population you are talking about it would be a major cause. Do you know what the other sources are there, Jack?

Mr. **Felton.** If we assumed that this plant was in full operation in 1972, which I hope, how many more years before the Hudson would then be fit for recreational type enjoyment?

Mr. **Carpenter.** Or any use that it is not now usable for.

In other words, I gather from your statement that you felt that the lower Hudson should not receive any sewage that had not had full secondary treatment.

Mr. **Moore.** I will extend that and say it is my opinion that none of the waters of the country, as a general proposition, should receive any municipal sewage that has not received secondary treatment. I feel that secondary treatment is one of the things which is technologically possible and, therefore, it is one of the things that ought to be achieved. Now you can get into some isolated cases that pose a hard question, and I have had them posed to me just in the time I have been here: Should a city with a population of 500 on the Mississippi River go to secondary treatment in terms of the volume of water that exists in the receiving stream? And there I will admit you get to a hard question. But as a general proposition, it seems to me that secondary treatment has to be recognized at this point in time as an absolute must, regardless of where the discharge is made.

Now with regard to the Hudson, your answer dodged what must be part of the problem, and that is this question in any receiving water. There are bound to be upstream discharges and probably industrial in the Hudson. There is an industrial stretch above the city of Manhattan.

Dr. **Hirsch.** I am sure in the Hudson you also have heavy discharges from commercial shipping and so on. But there is another problem that we are attempting to get on top of, and which we are not on top of it today. And it is a part of our overall recognition of the factors that we have to come to grips with if we are going to clean up the Hudson or any other river.

Mr. **Felton**. So you are saying, then, that this plant alone will not improve the Hudson.

Mr. **Moore**. It will not alone improve the Hudson River where the Hudson River will be available for all uses. But simultaneously with this approach on municipal sewage you must also be approaching all other discharges, plus the related problems of a harbor operation, refinery storage which I know exist on the New York side, all of the related problems that go with it having to be simultaneously attached in the same sense that you are moving on the municipal discharges.

Mr. **Barnhill**. You want to recognize that in a metropolitan area like New York where they have as much industry as they do, the water using and liquid waste-producing industry has to discharge its waste somewhere. In New York City's system a very large amount of industrial wastes are discharged and we call it municipal sewage, but you mustn't think it is all sanitary sewage. It is a combination of both. So the lower Hudson of course is subject to industrial pollution, either directly or through municipal sewage, sanitary wastes, vessel pollution, oil wastes, and so on.

Now let's take a look now at what we are trying to achieve there in the lower Hudson. As a result of public hearings and our enforcement conference, it has been determined that the best use of the Hudson, the lower Hudson, is for recreation, for fishing—I am talking about sports fishing—for boating, and other semidirect contact sports, and for esthetic enjoyment there is a big park along there that I think you fellows are aware of.

One of the things the city of New York is doing in relation to this plant is to extend that park right down alongside the waste treatment works. This is one of the requirements as I understand it of the metropolitan planning agency up there. This is going to be a pretty good thing, because it is going to be an elevated park. There is an expressway that runs along that site, and this park is going to have to be built up over the expressway. As far as I know, the city of New York has agreed to do this.

Mr. **Moore**. This has had an impact by the way on the design of this particular waste treatment facility. They have had to build into the design of this facility the landscaping requirements that would make it compatible with the existence of a park in the area.

Mr. **Barnhill**. And even beyond that, this plant is quite unusual, particularly for its size, because all of the tanks, sedimentation basins, aeration tanks and so forth, are all covered. Normally these are open. But here to make every effort to make the plant not only attractive in design but to control any nuisance from odors and so forth, these tanks are all covered. And it is designed in a very attractive way. I wish I had the artist's conception of that plant here, but it is quite attractive.

Mr. **Carpenter**. So you are then saying that for this investment in sewage treatment combined with all of the other improvements along the Hudson, the benefit will be new uses that can't now be contemplated at all?

Mr. **Barnhill.** That is correct. They will be able to have their Hudson River Park. As you may know legislation has already been enacted. We now have the Hudson River Basin Compact Act. They are striving to beautify that area of the Hudson physically, on both sides of the river, and to achieve these kinds of high uses—recreation, fishing, and so forth.

Mr. **Carpenter.** There is no sports fishing now in that area?

Mr. **Barnhill.** Oh, I am assuming there is some.

Mr. **Moore.** I have seen it. I would say there probably isn't any substantial degree of sports fishing, not in the sense in which you normally think of sports fishing. There may be some people putting lines in the water, but not sports fishing in the usual sense.

Mr. **Carpenter.** And there is——

Mr. **Felton.** You can do that on the Potomac.

Mr. **Moore.** Yes, sir.

Mr. **Carpenter.** There is no water skiing or pleasure boating.

Mr. **Moore.** No.

Mr. **Barnhill.** Well, there probably is some, but you see there is not as much as there would be if they are able to complete their objective of making this a beautiful, highly desirable place for people to come and enjoy the water and the parks and so forth.

Mr. **Carpenter.** Certainly the esthetic enjoyment must be at a minimum now.

Mr. **Barnhill.** I would guess that it certainly is.

Mr. **Moore.** This will be one of the first objectives you would reach. The primary treatment at least could provide, or certainly it would be one of the first steps in the direction of making it more esthetically attractive. You have seen water that was not esthetically oppressive, but you wouldn't get out on it for pleasure purposes.

Mr. **Carpenter.** Yes.

Mr. **Barnhill.** In the metropolitan area of New York, I think it is very easy to recognize that the part of the Hudson that runs through the metropolitan area there—the land along the sides and the water itself have got to be invaluable. I don't think you could put a dollar figure on what it is worth to the people in that area, if they can go down there and water ski and swim and fish and do all the things.

Mr. **Carpenter.** Do you think they would ever be able to swim?

Mr. **Barnhill.** Well, I will go along with Dr. Weinberger. I have a great deal of confidence in research, and I think that before 2010 it will be entirely possible to swim in the Hudson River.

Mr. **Moore.** Let me turn the answer around.

I think it would be unfortunate if we were at this time to preclude the possibility that you might be able to swim. It may take substantially more than we have done already to decide that you can't swim, and I would rather the decision not be made that you can't on the basis of the information we now have.

Mr. **Carpenter.** On that subject, Dr. Weinberger, the Potomac has been mentioned for some years as a possible swimming beach. But other comments have been made that the storm runoff would keep the coliform content so high that a Public Health officer might hesitate in allowing people to swim there.

Do you have any more recent studies or experiences that you could relate to us on that?

Dr. Weinberger. I would say that the same type of answer that Mr. Moore just gave applies. I think it would be a completely defeatist attitude to suggest that we couldn't have swimming in the Potomac River. From a technological point of view, there is no reason why we can't control the pollution sources, including the matter of the bacterial quality of the storm and combined sewer runoff.

Right now it is a matter of cost. I think it is a decision that the public must make as to the value which they will put to any particular use.

I personally think that the Potomac should be used for all purposes that the public wants including a swimming place for them. We can develop or we do have the technology to control pollution.

Mr. Carpenter. Will your program result in the placing of a cost figure on these various uses, and if so when could we expect such cost benefit figures to be available for major rivers and estuaries?

Dr. Weinberger. You want to comment on that, Al?

Dr. Hirsch. Well, I think we can expect the cost figures to be available much sooner than realistic benefit figures in many respects, and that is because so many of the benefits are intangible or nonmonetary in nature. We can put certain assumed values of a man-day of recreation for a person in New York City to enjoy the Hudson River. I personally think those are at least semiarbitrary when you are making comparisons of this sort.

Mr. Carpenter. Could you tell us, for instance, how much it would cost to say treat, that is to collect and treat the runoff, storm runoff in the Rock Creek watershed?

Dr. Hirsch. Oh, I think we could make estimates of that sort.

In fact, I think some estimates of a very preliminary nature of that sort were made in connection with some of the Potomac planning that has already been done. The trouble with these estimates is that they don't look at the full range of improved technology, the combinations of things that could be done. They just take the standard costs of separating combined storms. I don't think that is the total answer.

(The information requested is as follows:)

The complete separation of combined sewers in the Rock Creek Basin, has been roughly estimated at a cost of $105 million. However, this does not include provision for the effective collection and treatment of urban storm runoff, once it has been separated from sanitary sewage.

The solution to the storm water and combined sewer overflow problem at the present time appears to be collection, treatment, and chlorination of these flows before discharge. Treatment should probably include some form of coagulation and settling in a detention basin if a satisfactory quality is to be achieved. Such impoundment and treatment would also reduce the heavy loads of sediment, trash, and turbidity carried into the river by storm water, but disposal of the accumulated materials would present a problem of considerable magnitude.

The volumes of storm water which must be dealt with in a metropolitan area such as Washington at times of heavy rainfall, are very large. For intense storms, total volumes on the order of 6 billion gallons are involved. The collection, impoundment, and ultimate treatment and chlorination of such volumes presents substantial construction and operating problems. The "Final Report of the Interdepartmental Task Force on Project Potomac, Sub-Task Force on Water Quality" (February 1967) gives a very rough estimate based on extremely sketchy information and computations which indicates a total cost for the necessary works on the order of $2 billion for the entire metropolitan area. That illustrates the importance of seeking cheaper and more effective solutions.

Mr. CARPENTER. But even separating combined sewers would not mean that you could swim, as I had gotten the picture, because of the amount of organic matter that would just be picked off of streets and lawns.

Dr. HIRSCH. Well, I would say two things about that. One is that when you say even separating, separation may not be, or would not be I am quite sure the full answer.

Mr. CARPENTER. Yes.

Dr. HIRSCH. We may not want to go to separation in all cases. We may hold the first flush of storm water and pump it back in and so on.

Mr. CARPENTER. Yes.

Dr. HIRSCH. Also the frequency of storms. If you can provide bathing nine-tenths of the time during the summer months, you are still far ahead.

Dr. WEINBERGER. May I interject a point here about this storm and combined sewage? I think there is perhaps a certain amount of misunderstanding concerning our ability to handle in an effective manner storm and combined sewer overflows. One of the ways of getting at this problem is separation of your combined sewers. When the presentation was developed it was a preliminary figure, and it was apparent that we were talking in terms of tens of billions of dollars. The strategy at that time was that it was worthwhile investing in R. & D. to come up with more economical solutions.

This does not mean that we have no way of handling the problem. And we have in the last 2 years supported a number of projects which led to the treatment of or otherwise reducing the pollutional effects of storm and combined sewer discharges.

This gets back to the point that these solutions cost money. I think we have to recognize that we will not have any zero cost solutions. I think this is where some of the confusion comes up. Because from an engineering point of view, we can do almost anything, and to suggest that we can't, I think, is just a horrible condemnation on American engineering or scientific capability.

These are communities who have in the past handled their storm and combined sewer problems, some in an effective manner. Some new ideas have been developed in the last couple of years and these are being supported as a part of our research and development grant program.

We do have projects to treat the wastes and come up with a quality that would not result in a deterioration of your receiving water.

Mr. BARNHILL. Another consideration that we made in recommending that we not go full scale ahead on separation was not only the costs that Dr. Weinberger referred to but the fact that this would be quite a time-consuming thing in the city of Washington, for example, over a substantial period of time.

Mr. CARPENTER. Yes.

Mr. BARNHILL. The streets in the city of Washington would be torn up for weeks on end. This is an inconvenience that probably no mayor can suffer through. It would in effect be changing the law to say—well, Mayor Washington is not elected, but they would be one-term mayors, believe me.

Mr. MOORE. Well, there is something else important here I think, and this is an overall philosophical viewpoint. The mere fact that it, does not appear feasible at this point in time to physically separate storm and sanitary sewers doesn't mean that you should just wash your hands of the question.

Mr. BARNHILL. Yes.

Mr. MOORE. Let me just raise a question that has occurred to me from time to time.

Why can't you treat storm and sanitary sewage while it is in movement in the sewer itself, before it is discharged into the receiving water?

Dr. WEINBERGER. We have a number of projects right now that are exploring technology, and here again it is important to realize that many of the problems we are talking about today in the pollution field did not have the degree of recognition and the degree of priority that they have today. Therefore, there weren't people working on these problems. So really we are in the beginning of exploring some of these techniques. We do have proposals involving physical methods for treatment in sewers, chemical methods for treatment in sewers, in-sewer storage and a whole host of possible solutions which will be more economical than some of the alternates.

Mr. MOORE. I think we need to get back to the question he asked awhile ago, which as I recall was, How do you get from the uses to the standards? This is the question that I think Dr. Hirsch ought to tackle.

Dr. HIRSCH. I am sure you recognize already that the setting of standards initiates with the States and they go through the procedure and submit them in here. Philosophically or theoretically the way you get to the standards is composed of three things. The first would be a designation of what you want to use the water for.

Second, you would say to yourself what quality of water do you need to support that particular usage, and those would be the criteria, the numerical or descriptive values.

Third, you would say to yourself, now what do you have to do in the way of remedial measures to achieve that water quality.

Mr. CARPENTER. Let's go back to your first statement.

How is the choice of use made without some knowledge of the cost effectiveness data?

Dr. HIRSCH. Well, I think it is made on a kind, in most cases kind, of a commonsense appraisal of what the cost effectiveness is. And I guess this relates to Dr. Weinberger's comments, too.

The Chicago ship canal, for example: I am sure technology would be available to make that a recreational area and a fishery area and so on. But rule of thumb would tell us that that would be so tremendous in scale that it just isn't deemed feasible.

The general approach in this regard has been to look at what normally available, conventional waste treatment methods woul achieve in the body of water. On the general assumption that secondary treatment, for example, for municipal wastes is available, that it ought to be used widely, it is used widely, and the same for comparable measures in industry, and then to take a look at that and if that yields a quality of water which will support certain kinds of uses, that is a kind of a commonsense——

Mr. CARPENTER. So you use a circular process?

Dr. HIRSCH. Yes.

Mr. Carpenter. Of reasoning, checking against the available facts?

Dr. Hirsch. Right.

And the other thing I think we have to realize is that the standards that are being set are part of a trend here, in continuum, to try to reverse the downgrading of these uses and the downgrading of these values that have occurred, and they will be revised.

So what we have to do is we put in this conventional treatment that is available everywhere and then if we don't know, if we are uncertain as to its effects, we measure after it has been built, after it is in operation, and we see whether or not we have met our goals and expectations fully. If we haven't at that time maybe some of the newer methods will be available.

If they are not, in some cases we may have to say, well, for the moment we have done all we can in this area. It is so densely populated, so industrialized, that we have managed to prevent nuisance, but we are not going to be able to provide fishing in here as yet. I underline that as yet.

Mr. Moore. One of the inputs into the determination of uses, though, inevitably is historical uses.

Dr. Hirsch. The tendency is to want to either maintain the uses that are there at the moment or the ones you remember. I sat through 30 of these hearings and heard people say "I can remember when" and what they want to do is go back to where they can remember. So there is a certain amount of this, in other words, a restoration of a preexisting level of quality being the objective. So that went into the determination of what the uses would be.

Mr. Carpenter. Now, in this same line of questioning, the recent judgment by the Secretary that no degradation would be allowed, carries with it what some critics have termed a loophole in these words:

> Unless and until it has been affirmatively demonstrated to the State Water Pollution Control Agency and the Department of Interior that such change is justifiable as a result of necessary economic and social development and will not interfere with or become injurious to assigned uses made of or presently possible in such waters.

Could you discuss this and perhaps defend against this loophole charge?

Mr. Moore. Well, let me address myself to that question. And I think you need to appreciate I am a relative newcomer to the question.

What is involved here is first of all what does the addition of a new discharge do to an existing water quality.

Now first of all you could have a situation in which the new discharge, because of its composition, would not have any effect on the quality of the receiving water.

In other words, it may be a municipal discharge for which the highest treatment is to be provided or it may be an industrial discharge for which the technology is available to maintain the quality of water that exists in the receiving stream.

So that you could have where there is a consideration as to permitting a new discharge, a situation which the new discharge would have in the sense of the uses of the water no effect. Well, that would be the easy case.

Now it seems to me that inevitably you come to the situation where the existence of the high-quality water may also coincide with other circumstances that are socially or economically desirable. For example, a high-quality water in an undeveloped area or a high-quality water in an area that is economically depressed—and there are some of these in the Nation.

Well, here it seems that you would weigh the degree of degradation that might occur from this waste. You understand I said might, because you always have a technology involved. You weigh the amount of degradation that might occur in terms of the social or economic benefit that would accrue from allowing this discharge.

Mr. CARPENTER. So this is no more of an extension of your commonsense approach to the establishment of present standards?

Mr. MOORE. That is what I would regard it. You can I think see the potential, however, for some rather strong positions or disagreements as to whether it will or will not meet the conditions that are outlined in the Secretary's statement.

Mr. CARPENTER. These are choices ultimately that would have to be made by society?

Mr. MOORE. Yes.

Mr. CARPENTER. Weighing the facts that you can provide for them?

Mr. MOORE. And in this instance ultimately it would have to be weighed by the States and the Department of the Interior in terms of the quality of water.

There undoubtedly will be those cases in which there may be a serious question about whether you should permit any discharge at all. I think we would have to admit the existence of some areas in the country in which it may be desirable to have no discharges. However, there are areas in which there are high-quality waters that are subject to economic and social development that can't otherwise occur, and it seems to me in these instances is where you will be faced, the States and the Department of the Interior will be faced with making a decision.

Mr. CARPENTER. I would like next to discuss eutrophication. The information which you have given us on eutrophication answers a number of these questions. We will consider putting that in the record.

One question remains. From the standpoint of making realistic forecasts of the future status of lakes and estuaries which now contain a substantial nutrient content, could you tell us what happens in a closed body of water or an estuary with little change in water if new additions of nutrients are slowed or halted but the present nutrient content is not removed by any actual treatment of the lake itself? What can we expect in terms of improvement of that water through natural processes and what time would be required before that water would show any improvement if indeed it ever will?

Dr. WEINBERGER. The current approach to the control of the undesirable effects of accelerated eutrophication, normally considered to be excessive algae growths or algae blooms, is to reduce the nutrient levels in the body of water. And what is necessary using this method, is to reduce any one of the elements below a concentration which is needed for the life of those organisms.

Therefore, in order to stop the bloom or the algae growth, we have to reduce the concentration of a nutrient.

We must keep out or reduce the amount of nutrients going into the lake. There is a very simple material balance. If it comes into the lake, it either stays there or it goes out. If more is going out than is coming in, then eventually the lake will clear itself up. This may take a very long time in the case of lakes.

As an example of this, it was suggested that the detention time or the holdup time in portions of Lake Michigan, the southern portion of Lake Michigan, is actually measured in terms of decades or possibly centuries, where in small lakes the amount of time necessary to in effect replace the lake may be in terms of years.

To reduce nutrient levels you must have more nutrients coming out than going in.

Now one of the reasons why this is such a difficult problem is that the nutrients recycle—let me deal with one of the elements, and that is phosphorus. The organisms take the phosphorus out of the water and use the phosphorus to make living material. When the organisms die and decay, they then release the nutrients. The phosphorous is then available for the following year.

So in direct answer to your question, if you reduce the amount of nutrients going into a very low level such that the amount coming out is far greater, you can then begin cleaning the lake.

In the absence of that favorable situation, then in addition to controlling the nutrients going in you have to have some way of accelerating the removal of the nutrients that are there.

Now there are a number of ways of doing this that have been proposed, ranging from such things as trying to harvest the algae and remove them physically from the lake and taking with them the nutrients. It has been suggested that we might try and effect the entire biological system and perhaps have fish consume algae and then harvest the fish. The suggestion has been made that in some cases we may want to remove some of the deposited material.

Mr. CARPENTER. From the bottom?

Dr. WEINBERGER. From the bottom to take out some of the nutrients.

Mr. MOORE. Any one of which on any sizable body of water is a difficult process.

Mr. CARPENTER. Right.

Dr. WEINBERGER. And expensive.

Mr. CARPENTER. I think the important thing, though, here is that the mere stopping or retarding of the nutrients into the body of water will not necessarily cause the body of water to clean itself up. If the cycle has been established within the body of the water so that it is self-contained, then you do not change that cycle by reducing or eliminating the nutrients flowing into the body of water.

Dr. WEINBERGER. Yes. And I would say here that this ties in with some of your previous comments.

Mr. CARPENTER. Yes.

Dr. WEINBERGER. And that is the concept that when you put in a water pollution control project you necessarily get immediate results.

In other words, what you are doing is contributing to the solution.

Mr. CARPENTER. Yes.

Dr. WEINBERGER. In this case one of the first things that we must do is stop nutrients from going in. This is a step in the right direction. The next step will be to accelerate the removal of the nutrients that are there.

Mr. Carpenter. That takes care of that question as far as I was concerned.

Dr. Weinberger. Dick, may I comment for your record on this phosphate problem?

Mr. Carpenter. Please do.

Dr. Weinberger. The question is frequently asked is eutrophication caused primarily by phosphates. Eutrophication means enrichment and enrichment in the biological sense means the providing of food materials. One of the foods or nutrients that organisms require at the algae level is phosphates, but they also require a whole host of other elements including the same elements which we would need in our nutrition. They would be such things as carbon, nitrogen, sulphur, potassium, and so forth.

If one wants to go to starving of the organisms—and this is what we mean by nutrient control—and again the implication here is the same thing in dealing with human nutrition—we need control but one element. In other words, any one of the elements is essential to life and if we can control any one of these we should be able to, and we can, control the growth of these organisms.

Now in taking a look at the elements which might be controlled, we first take a look at the macro, that is the larger scale, requirements. One of the macro nutrients would be phosphorous. Of all of the nutrients, it seems that phosphorous is the one most likely to be controlled. And this is the reason for the emphasis on phosphorous control in most bodies of water.

There are some situations where there is sufficient phosphorous in natural waters so that this is apparently not the controlling element and in those cases one might control the process by reducing nitrogen.

From a long point of view there have been many suggestions made, all of which have scientific validity, and that is, if one could find a micro nutrient, such as cobalt, and if we could reduce its concentration below the critical level, we would likewise stop the growth of these organisms.

This is the reason why you find in the literature suggestions that we might try to control a vitamin. And again relating back to human nutrition you can actually starve a person by them not having a particular vitamin, even though their caloric intake is quite adequate.

Mr. Carpenter. Is there any possibility of a specific herbicide as an approach to algae control?

Dr. Weinberger. This is always a possibility, of trying to find a very specific chemical control. This must be approached with a good deal of caution, because this is very seldom that specific. There have been chemicals added.

Mr. Carpenter. Copper sulphate?

Dr. Weinberger. Copper sulphate to control algae and in limited cases it can be effective. I would say its most effective application is in terms of a swimming pool, but in terms of any continual application we would much prefer to not resort to chemicals which now add another impurity into the environment.

Mr. Carpenter. One question remained from the prior hearing and that is that I have noticed the Department's releases, when the State standards are approved, do not give the numerical standards, that is the temperature rise or the salinity and so on.

Now are these matters of public record, and could we have a table by States and by contaminant or property of the water to show what those numerical values are?

Dr. HIRSCH. Well, the standards are public documents, and the way we have dealt with the issue to date is to have an available supply of these for public inspection. Reading copies of the standards are available in our Washington, D.C. headquarters and in the regional offices.

Now, some of these documents, as you may know, are literally about that thick (indicating). Others are a small booklet.

We do have underway, although I am not quite sure when it will be completed, the compilation of summary reports which will serve the purpose that you described, namely, taking this vast conglomeration of material and putting it down in simple form. We don't have those available today.

Mr. CARPENTER. Maybe I am asking for something that is impossible, but can you imagine a three-dimensional matrix, one dimension being States, the second dimension being use, and the third dimension being criteria. For example, salinity standards for industrial water use by States?

Dr. HIRSCH. I think you are asking for something that would take perhaps four dimensions here, and the reason for that is that a State might have a range of rivers for which salinity was classified to support industrial water use. Some States do have statewide criteria for a given usage, like fisheries. They would say any stream in the State designated for fisheries should meet the following numerical limits.

Other States, on the other hand, have tailored individual waters with some relationship to the existing quality and so on. So that there would not be one statewide, what have you, criterion.

I do think that we will somewhere along the line categorize the criteria that have been adopted for industry by parameters. I might say that the report of the National Technical Advisory Committee does this in a recommendatory sort of way generally.

Mr. CARPENTER. Yes.

Dr. HIRSCH. But then what the States submit and what the Secretary approves is perhaps more germane to what you are looking for here.

Mr. CARPENTER. I had made a study of that interim report and it seemed to me that there were certain uses which encompassed almost all of the properties, for instance, aquatic life. If a stream is chosen to support aquatic life, then it is useful for almost every other purpose——

Dr. HIRSCH. Well——

Mr. CARPENTER. With the exception of drinking water.

Dr. HIRSCH. That is not necessarily true, because, let's take salinity, which is a major problem in some of the Western States. Many of those streams support aquatic life and support recreational usage at levels of salinity which do substantial damage to industrial water supply or municipal water supply or agricultural use.

Mr. CARPENTER. I see.

Dr. HIRSCH. The general rule of thumb is, sure, if it supports fish, it is great for all uses, but in a more specific and scientific sense that is not necessarily true.

Dr. Weinberger. Dick, we have tried to do this, and I think you are getting from Alan the same one you got from me.

Dr. Hirsch. I hope so anyway.

Dr. Weinberger. In terms of trying to come up with this simple matrix, it gets extremely complicated. I worked on this one weekend trying to see if you couldn't boil it down. What happens, for example—take one that you are very much interested in—temperature.

Mr. Carpenter. Yes.

Dr. Weinberger. The temperature criteria for fish. What you quickly find out is that this varies from State to State because you have different species of fish.

Mr. Barnhill. And stream to stream.

Dr. Weinberger. Stream to stream. And you have different latitude. But more than that, in other words, for this, then you run into the fact that it isn't only a specific temperature that one is talking about. You are talking about temperature during particular times of the year.

Dr. Hirsch. Any combination with other conditions.

Dr. Weinberger. And you are talking about rates of temperature rise. So you find that to pick out a number, you know, just some number, which you can apply uniformly across the United States, and from State to State, is going to be lacking. But this does not mean that they are not consistent. When I looked at some of the standards as to which could be uniform, it really relates much more to the amenities. In other words, you can say that you don't want to have any floating matter.

Which are signs of fecal pollution. This is a uniform standard across the country. Or you want to have something which is substantially free of oil. But when you get into any of the uses like fishing or for human health, for swimming, you begin getting into some very vast differences. To present the data in a table you have to simplify it so that it loses any meaning.

Mr. Carpenter. Well, I realize that difficulty, and I was just hoping that ultimately your program could do that and then add a fifth dimension, which would be the cost of achieving this, which would have to take into account the present status of the water.

Dr. Hirsch. Of course the cost report that you see before you is a first effort which has to be updated annually to do just that, to estimate the costs.

Mr. Carpenter. Yes.

Dr. Hirsch. Of meeting water quality standards.

Now it was done on a State basis, on a regional basis and so on, and we will refinance it from year to year. So hopefully, you would be able to pick up that report and say that in the next 5 years it is going to cost so many dollars to meet the water quality standards which have been established by the State of Indiana or Michigan or Ohio.

I don't think this first year's report quite gets us to that point, but I think we will be at that point by next year. So that at least answers the cost half of the question that you have asked.

Mr. Carpenter. Right.

Dr. Hirsch. As to the other question, I think it is more a matter of summarizing the standards submitted by any State so that anyone can pick up in a very brief document and understand basically what they mean.

Mr. Carpenter. I wanted to ask this other question, then.

Mr. Felton. Go ahead.

Mr. Carpenter. Do you know of any case when enforcement of water quality standards has caused a business operation to relocate, go out of business, or shut down a specific operation? In such cases, has there been a court challenge?

Dr. Hirsch. I don't personally know specifically of such cases. I know that is a widespread concern.

Mr. Carpenter. Which is why I asked the question, in hopes of laying it to rest.

Dr. Hirsch. I think it really might have only relevance to some marginal industries in some cases, you know a claim that an industry is shutting down because a certain requirement has been imposed upon it sometimes means the industry was going to close down anyway and they were looking for a way to do it.

Mr. Carpenter. An obsolete papermill?

Dr. Hirsch. That is right, a corporation that has one marginal and six more viable plants. It doesn't want to shut down, so it cites tax increase or something else as the causative factor.

There may be cases and there may have been court challenges. I don't personally know of those. I think it does resolve meeting water quality standards in an economic sense. If there are difficulties from an economic standpoint, I think our studies indicate that they would be in a case of the rare exception—the marginal firm that is just barely making it, and so on.

Mr. Carpenter. Has any case ever reached a court?

Dr. Weinberger. John?

Mr. Barnhill. Well, I don't know of any. This question has been around. I have been in business 32 years and it was here when I started, and I guess it will be with us for some time, although you don't hear near as much of it as you used to.

I don't personally know of any business that was forced to close its doors because of its pollution control requirements. I agree with Dr. Hirsch, that it might have been the deciding factor. They couldn't make up their minds, but this did it.

There have been some instances where an industry said it did close its doors because of pollution control requirements, but when the States looked into it they found out it was some other factor, such as a threatened strike for increased wages or some such thing as that.

I don't know of any and as I said, since the question has been around a long time, we have all spoken frequently to the States about it, and they have never once given us an example of where industry shut down because of pollution control.

Now we haven't tried to enforce any of the new standards.

Mr. Carpenter. Yes.

Mr. Barnhill. But I think we can get at it a little different way. We have had 42, I believe it is, enforcement conferences——

Dr. Hirsch. Forty-four.

Mr. Barnhill. Forty-three—that is right, 44, and in effect the recommendations that the Secretary makes as a result of these enforcement conferences is a standard-setting exercise.

Mr. CARPENTER. Right.

Mr. BARNHILL. It is agreed on the degrees of treatment, the desired water uses they are trying to reach, and so forth. So it is somewhat the same thing. In these 44 cases, I know of no instance where an industry has gone out of business.

Mr. CARPENTER. Have any of those reached court?

Mr. BARNHILL. No. Now we took one city to court.

Mr. CARPENTER. St. Joseph?

Mr. BARNHILL. Right. But this was in the opposite direction from what you are inquiring about.

Mr. CARPENTER. Did they get an injunction against the city?

Mr. BARNHILL. No, no. After we referred it to the district court, the city held another bond election and this time with the case in the court, the people voted the bond issue and the project proceeded. The case is still in the court, and it will stay there until they have completed their requirements.

Now since the standards have been in the process of promulgation, negotiation, and adoption, there is only one instance that has come to my attention of where an industry said that the standard was going to put them out of business, and this is a little gold mine up in South Dakota, at Lead, S. Dak.

Mr. CARPENTER. Is it a cyanide problem?

Mr. BARNHILL. It is partly cyanide. I think they consider that their major problem, but there are some problems of sediment attached to it, too. But the State says the company can afford to do it. It has been an issue up in South Dakota apparently for several years. It has tried to get the company to comply and have worked with the company in a couple of nearby communities on a joint project, but the industry apparently isn't buying any approach. This is an informal appeal to the Secretary only. No threat to go to the courts or anything like that.

Mr. FELTON. Let me ask one question on the Federal departments reporting the pollution which they are causing. I understand this is in some type of report form which is about to be released, is that correct?

Dr. HIRSCH. I am sorry, I don't——

Mr. FELTON. This is Executive Order 11288.

Dr. HIRSCH. Oh, the extent of Federal activities in various parts of the country which are polluting?

Mr. FELTON. Yes. Is this information available to the public?

Dr. HIRSCH. We are working on reports on that. I don't know what the status is.

Mr. BARNHILL. Well, the information we have is certainly open to the public, and what we have is a national inventory of waste discharges from Federal installations. Was it 1962 when it was completed?

Dr. HIRSCH. That is the major one, nationwide.

Mr. BARNHILL. Yes. We have picked up data in the meantime and have been able to improve this inventory a little bit. But I think what you are talking about is recently we have had a flurry of requests from various Senators and Congressman to give them a list, or an inventory, if you please, of the Federal installations in their States or their districts. We have tried to respond, but within our resources this is quite difficult.

Mr. **Felton.** Well, if a private individual or a corporation wanted this type of information, what would they do?

Mr. **Barnhill.** Well, they could write to us and if we had the information we would certainly supply it.

Dr. **Weinberger.** John, could we go back?

There was a report, that was a congressional document——

Mr. **Barnhill.** That was based on our inventory.

Dr. **Weinberger.** Yes.

Mr. **Barnhill.** You are talking about the Jones committee report.

Dr. **Weinberger.** The Jones committee report, which listed the sources of waste from Federal installations, is available. I think John says it is about 5 years old.

Mr. **Barnhill.** The committee report is about 5 years old. Our inventory is about 6 years old.

Mr. **Felton.** Is this being updated at all?

Mr. **Barnhill.** Well, not on a national scale. We would like to update it.

Mr. **Carpenter.** It was the air pollution that Middleton mentioned as being a new report. And they told me that that would not be made public until the President's message on environment.

Do you have a similar submission?

Dr. **Hirsch.** Not as an inventory of Federal activities.

I might say I wouldn't think that you would want to get the impression that we are still relying however on data which was gathered in 1962.

The regional offices and our people, from the standpoint of working files, of course, have much more up-to-date information on many specific cases, specific river basins, and things of that sort. But if you are talking about a compiled source where you have the report there, to give it out, the inventory is the last major compiled source of this sort. But, for example, on the Potomac River Basin or something anywhere else, in terms of working files or memorandums or other documents and working with the agencies, this is——

Mr. **Barnhill.** This is the result of the Executive order. Of course we have set up a working program in each one of our regions.

Mr. **Felton.** Going back to your statement that there were no enforcement cases, section 10 is the enforcement section of your law. Could you give us for the record a rundown of what States have submitted plans and which ones have been adopted? And in the case of any State which has not submitted a plan, whether or not you have prepared water quality standards for that area? This type of background information will be helpful so we see where the whole thing stands.

Mr. **Barnhill.** You mean a status report on water quality standards setting?

Mr. **Felton.** Yes.

Dr. **Weinberger.** I think this is one of the questions I am also responding to, but one of the problems is it changes every day and as the Secretary approves more standards——

Mr. **Felton.** All you have to say is "as of."

Dr. **Weinberger.** I know, but they ask this question.

Mr. **Felton.** Yes.

(The information requested is as follows:)

All States and Territories submitted water quality criteria and implementation plans under the Act. The following States criteria and plans have been approved as Federal standards as of April 18, 1968.

Water Quality Standards Approved Under The Federal Water Pollution Control Act, as Amended

Georgia
† Oregon
New York
† North Dakota
South Dakota
Arkansas
* Idaho
Massachusetts
Maryland
Indiana
** Washington
** Wisconsin
* Texas
** † Michigan
** † Illinois—Chicago River and Calumet River Systems; Illinois River and Lower Section of Des Plaines River; Rock River, Fox River, Des Plaines River, Kankakee River and certain named tributaries; and Lake Michigan, Little Calumet River, Grand Calumet River and Wolf Lake
* † Rhode Island
* † Missouri
* † Louisiana
* † Alabama
* † Connecticut
* † Alaska
* Virgin Islands
* † Tennessee
* † Oklahoma
* Montana
* † Ohio
* Hawaii
** † New Jersey
* † Delaware
* † District of Columbia

Total: 28 States; 1 Territory; District of Columbia.

Areas Reserved From Approval

Oregon—Klamath River and Goose Lake Drainage Basins.

North Dakota—Red River of the North Basin.

Michigan—Temperature criteria for protection of fish, wildlife and other aquatic life.

Illinois—Dissolved oxygen and temperature criteria for protection of fish and aquatic life for the Chicago River and Calumet River Systems (SWB 15); Illinois River and Lower Section of Des Plaines River (SWB 8); Rock River, Fox River, Des Plaines River, Kankakee River and certain named tributaries (SWB 11).

Rhode Island—Interstate waters covered by the Federal Enforcement Conference on the Blackstone and Ten Mile Rivers; dissolved oxygen criteria for Class C and Class SC waters.

Missouri—Dissolved oxygen criteria for the Missouri River and that portion of the Mississippi River below Alton Lock Dam.

Louisiana—Interstate waters classified for propagation of aquatic life where the minimum dissolved oxygen is set at 50% saturation.

Alabama—Temperature and dissolved oxygen criteria for shellfish harvesting and fish and wildlife.

Connecticut—Dissolved oxygen criteria for protection of fish, shellfish and wildlife in waters classified as C, Cc, SC and SCc.

Alaska—Items 8 and 9 on "Sediment" and "Toxic or other Deleterious Substances, Pesticides and Related Organic and Inorganic Materials."

Tennessee—Temperature criteria for protection of fish and aquatic life.

Oklahoma—Dissolved oxygen criteria for protection of fish and wildlife propagation, including smallmouth bass fisheries.

Ohio—Mahoning River; odor criterion for Little Beaver, Yankee, and Pymatuning Creeks; temperature and dissolved oxygen criteria for "Aquatic Life A."

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†Partial approval.
**States with acceptable "degradation" language.
*States which have already been asked to adopt a "degradation" statement.

New Jersey—Dissolved oxygen criteria for FW-2, FW-3, TW-1, CW-1 and CW-2; temperature criteria for all coastal and tidal waters except Delaware Bay and Estuary and temperature change limits for FW-2 and FW-3 trout waters.

Delaware—Treatment requirements for Delaware City and Milton; dissolved oxygen value of 50% saturation where applied to fresh waters.

District of Columbia—Dissolved oxygen and temperature criteria.

Mr. CARPENTER. I would—recognizing the difficulty which we just heard about, could we take a half dozen properties—say dissolved oxygen, rise in temperature, salinity, residual BOD, and maybe one or two others, and get a table of the actual numerical standards that you approved, by State?

Dr. WEINBERGER. When you put it that way——

Mr. BARNHILL. Can I—I don't want to seem to be uncooperative, or unresponsive or anything, but this could only come from our water quality standards staff, who are——

Mr. CARPENTER. Busy?

Mr. BARNHILL. Well, it has the highest priority in the Department, not only in FWPCA, but in the Department. The Secretary, of course, is anxious to get on and to get these approved and these people are really up to their ears.

Now I will be happy to ask the director of the staff over there if he thinks he can possibly do this for you. If he can, if I can, we will be happy to do it.

Mr. CARPENTER. If he could do it for one use, say sport fishing—again, what I want it for is not idle curiosity, but I would like to see both the actual levels that you have approved with respect to this interim report of the technical advisory committee and also I would like to see what variation there would be between States.

Mr. BARNHILL. Well, I will see——

Dr. WEINBERGER. Dick, let me come in.

One of the things behind all this, John, is apparently a certain amount of confusion as to the amount of scientific data available in terms of setting of standards. Now you remember I referred to you the report that Jack McKee prepared.

Mr. CARPENTER. Yes; California——

Dr. WEINBERGER. With support from our agency.

Now, if we take any one of these—and here is one of the things you were asking about. Here, for example, is dissolved oxygen.

Mr. CARPENTER. Yes.

Dr. WEINBERGER. These would have to be updated, but you see just in the case of dissolved oxygen, here is a general statement, and then this is related to domestic water supplies, fish and other aquatic life, and you see it starts——

It starts running here. Now here is shellfish culture. Now here is dissolved solids. You see, there is a general statement. Then it relates to effects upon beneficial use, which you are talking about. Now here is domestic water supply—I am trying to read upside down. Here is for industrial waters. Here is for irrigation water.

Mr. CARPENTER. Let's go back to this dissolved oxygen now. In summary he says:

> On the basis of available information described above, it is not feasible to attempt to suggest an optimum dissolved oxygen content of water to domestic, industrial, stock and wildlife or recreational uses, or fish and other aquatic life. The recommendations of the Aquatic Life Advisory Committee of Orsanco, as quoted above, appear to be logical.

So may I assume that you would approve no State standard for dissolved oxygen for fish and other aquatic life which would be lower than 5 milligrams per liter during at least 16 hours of any 24-hour period?

Dr. **Weinberger.** Well, they have these figures. Now again, these are not our criteria. All I am indicating—you see this is about 4 or 5 years old.

We set up some technical advisory committees. We have asked them to go back and take a look at all of the information that has been developed, and on the basis of that to bring our current knowledge up to date.

Now, it is on the basis of this available knowledge that you are able to say that, now if you are going to protect a stream for trout, then this should be dissolved oxygen that you are going to maintain. They would not—John, correct me if I am wrong. We would not deviate from that if the uses for trout—we are talking about the same trout. Then this would be the criteria that would be established for DO and these would be the levels.

Mr. **Carpenter.** Could we have that a month from now?

Mr. **Barnhill.** Well, how would it be—let's have DO because that is one that is somewhat in controversy. I will have them provide you with the State and then a statement on the dissolved oxygen criteria that have been approved by the Secretary. There have been 16 State plans approved so far.

You are going to find in some of these instances they were approved without approving the DO criteria for certain streams. So whether we can eventually resolve this with the States or whether the Federal Government states the DO standard we don't know yet, but I will give you a status report on DO, on the 16 States that have been approved so far. And you will find variations in them. It is not really cut and dried. We have pushed the States as far as we could in getting them to upgrade their DO criteria. In some instances you will find that the Secretary appears to have approved the standard that is not as high as it should be, but this is an instance of the State cooperating with us and trying to upgrade and enhance the water that is already seriously polluted.

It is an attempt to bring it up to a good quality water. It is going to vary, because it depends on whether you are talking about a warm water fishery or a cold water fishery or whether you are talking about lake trout or stream trout, or whether you are trying to protect an anadromous fishery. So they will vary. You will see differences there.

Dr. **Weinberger.** May I suggest this, Dick, that when they come up with the thing—again, we worked on this thing. When you get the table, let us help you interpret it. Because as I say, it may not be uniform but it is consistent. I think this is the thing you want to get on the record, to show—I didn't mean to overwhelm you when I gave you this. The question raised, you know, well is there any scientific base. Well, here is a report which has 3,800 references. As a matter of fact, there was an addendum to this. Now these are all representing scientific investigations and studies.

Mr. **Barnhill.** And difference of opinion.

(The information requested is as follows:)

DISSOLVED OXYGEN CRITERIA (MINIMUM)

State	Cold water fishery	Warm water fishery	Miscellaneous (highest use in stream)
Oregon	75-percent saturation at seasonal low or 5 to 7 mg./l, by stream; 95 percent saturation in spawning areas during spawning, hatching and fry development. fry development.		Marine—not less than saturation. Estuarine—6 mg./l.
Idaho	75 percent saturation at seasonal low; 100 percent in spawning areas during spawning, hatching and fry development.		
Indiana	6 mg./l daily average 4 mg./l anytime.	5 mg./l—16 hours per day 3 mg./l—anytime	
Georgia	5 mg./l	4 mg./l	Industrial and navigation—2.5 mg./l.
Massachusetts	5 mg./l	5 mg./l—16 hours per day 3 mg./l—anytime	Coastal—not less than 6.5 mg./l. Industrial—2 mg./l.
Maryland	5 mg./l minimum 6 mg./l monthly average	4 mg./l minimum 5 mg./l monthly average	Industrial—4 mg./l.
North Dakota		5 mg./l, or 5 mg./l—16 hours per day and 3 mg./l anytime, by stream.	
South Dakota	6 mg./l or 5 mg./l, by stream.	4 mg./l	
Arkansas	5 mg./l	4 mg./l or 50-percent saturation.	
New York	5 mg./l	4 mg./l	Agricultural—3 mg./l. New York Harbor—2.5 mg./l.
Washington	5 mg./l, 6.5 mg./l, 8 mg./l or 9.5 mg./l, by stream.		Marine and estuarine-waters—4 mg./l (or 50 percent-saturation), 5 mg./l (or 70 percent saturation), 6 mg./l or 7 mg./l, by water area.
Wisconsin		5 mg./l—16 hours per day 4 mg./l anytime.	Fish life—80 percent saturation or 5 mg./l.
Texas		5 mg./l, 4 mg./l, or 3 mg./l, by stream.	Houston Ship Channel—2 mg./l.
Michigan	6 mg./l	5 mg./l—intolerant species. 4 mg./l—tolerant species.	Navigation—3 mg./l.
Rhode Island	5 mg./l [1]	5 mg./l—16 hours per day [1] 3 mg./l—anytime.[1]	Sea water—6 mg./l. Navigation—2 mg./l.
Missouri		5 mg./l—except	Missouri River—4 mg./l.[1] Mississippi River—below. Alton Lick Dam—4 mg./l.[1]
Louisiana		50-percent saturation [1] or 60–75 saturation in some waters.	
Alaska	6 mg./l—salt water 7 mg./l—fresh water.		Shellfish spawning—6 mg./l.
Illinois	(1)	Lake Michigan not less than 80 to 90 percent saturation; other interstate waters.[1]	
Tennessee	6 mg./l	5 mg./l except in limited sections of stream receiving treated effluent—3 mg./l.	
Virgin Islands			Marine Life—5.5 mg./l. Harbors—5 mg./l.
Ohio	6 mg./l	Aquatic Life A—[1] Aquatic Life B—3 mg./l average, 2 mg./l minimum (applied only where no higher levels can be attained with treatment).	
Hawaii			Coastal waters—Class AA—6 mg./l. Class A—5 mg./l. Class B—4.5 mg./l—limited to docking areas. Fresh waters used for fish propagation 5 mg./l.

Footnote at end of table, p. 508.

DISSOLVED OXYGEN CRITERIA (MINIMUM)—Continued

State	Cold water fishery	Warm water fishery	Miscellaneous (highest use in stream)
New Jersey[1]		All[1] except	FW-1, to be maintained in natural state. Delaware River: Zone 2—daily average 5 mg./l except Apr. 1 to June 15 and Sept. 16 to Dec. 31—6.5 mg./l. Zones 3, 4, and 5—daily average 3.5 mg./l except Apr. 1 to June 15 and Sept. 16 to Dec. 31. Delaware Bay—daily average of 6 mg./l. Atlantic Ocean—natural.
Delaware		50-percent saturation[1] or 4 mg./l except Delaware River—daily average 3.5 mg./l except Apr. 1 to June 15 and Sept. 16 to Dec. 31—6.5 mg./l.	Delaware Bay—daily average of 6 mg./l. Other coastal waters—50 percent saturation[1] or 4 mg./l. Chesapeake and Delaware Canal—6 mg./l.
District of Columbia		(1)	

[1] Not approved by Secretary.

BACTERIOLOGICAL CRITERIA IN APPROVED STATE STANDARDS*

PUBLIC WATER SUPPLY

Standards generally reference the U.S. Public Health Service Drinking Water Standards (1962) in establishing criteria for protection of public water supplies. Raw water supplies are protected by total coliform and/or fecal coliform limits. Typical examples are given below:

Total Coliform.—Coliform bacteria content shall not exceed an average of 10,000 per 100 milliliters (ml) in any month.

Fecal Coliform.—Fecal coliform bacteria count shall not exceed an average of 2000 per 100 ml in any month.

FULL BODY CONTACT RECREATION

Typical criteria are as follows:

Total coliform.—Average concentrations of coliform bacteria shall not exceed 1000 per 100 ml, with 20 percent of samples not to exceed 2400 per 100 ml.

Fecal coliform.—Fecal coliform shall not exceed a geometric mean of 200 per 100 ml based on at least 5 samples per 30-day period, and shall not exceed 400 per 100 ml in more than 10 percent of the samples.

PARTIAL BODY CONTACT RECREATION

Typical criteria are as follows:

Total coliform.—Coliform group not to exceed 5000 per 100 ml as a monthly average value; nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than 5 percent of such samples.

Fecal coliform.—Same as Public Water Supply.

SHELLFISH HARVESTING

Coastal States utilized the U.S. Public Health Service shellfish sanitation manual in developing criteria for protection of shell fisheries. Total coliform limits are used, as follows:

Total coliform group shall not exceed a median concentration of 70 per 100 ml.

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*Criteria based on Most Probable Number or membrane filter counts in a representative number of samples.

TEMPERATURE CRITERIA IN APPROVED STATE STANDARDS

ARKANSAS

20° C. Maximum in trout streams.

30° C. Maximum in smallmouth bass streams.

35° C. Maximum in other streams.

The temperature of a stream as determined by natural conditions shall not be increased or decreased more than 5° F. by discharges thereto.

GEORGIA

Public Water Supply—not to exceed 93.2°F. (34.0°C.) at any time and not to be increased more than 10°F. above intake temperature. In streams designated by the State Fish & Game Commission as trout waters, there shall be no elevation or depression of natural stream temperature.

Recreation—same.

Fish, shellfish—same.

Industrial—not to exceed 93.2°F. at any time and not to be increased more than 10°F. above intake temperature.

IDAHO

No measurable temperature increase when stream temperature is 68°F. or above, or more than 2°F. increase when river temperature is 66°F. or less (except 70°F. and 68°F., respectively, in Snake River—RM 407 to 247).

INDIANA

Aquatic Life—(warmwater fisheries) temperature not to exceed 93°F. at any time during the months of April through November, and not to exceed 60°F. at any time during the months of December through March.

Trout Streams—temperature is not to exceed 65°F. (However, slightly higher temperatures may be tolerated with higher dissolved oxygen content than specified). (This criterion is in addition to the temperature criteria above.)

Drastic or sudden temperature changes are not permitted. Gradual changes in temperature may not exceed 2°F. per hour nor more than a total change in 24 hours of the maximum diurnal change or 9°F. whichever is greater.

MARYLAND

Section 7.60—Temperature standards (Temp.):

Temp. 1.—For all water use categories other than IV, there must be no temperature change that adversely affects fish, other aquatic life, or spawning success. There must be no thermal barriers to the passage of fish or other aquatic life. Maximum temperature must not exceed 100° F. beyond 50 feet from any point of discharge.

Temp. 2.—For nontidal waters.—For "trout waters," waters so designated to the Department by the Department of Game and Inland Fish, temperature must not exceed 72° F. at any time. For the propagation of fish and other acquatic life (Water Use Category IV) in all other nontidal waters, temperature must not exceed 93° F. beyond such distance from any point of discharge as specified by the Department as necessary for the protection of the water use. In addition for all nontidal waters other than "trout waters," maximum temperature elevation is to be limited as follows:

For natural water temperatures of 50° F., or less, the temperature elevation must not exceed 20° F. above the natural water temperature, with a maximum temperature of 60° F.

For natural water temperatures greater than 50° F., the temperature elevation must not exceed 10° F. above the natural water temperature, with a maximum temperature of 93° F.

Any deviation, other than natural, from the above requirements is to be evaluated for risk to the propagation of fish and other aquatic life by the Department of Game and Inland Fish, and will be permitted or denied by the Department of Water Resources after consultation with that agency.

For tidal waters used for the propogation of fish and other aquatic life (Water Use Category IV), temperature must not exceed 90° F. beyond such distance from any point of discharge as specified by the Department as necessary for the protection of the water use. In addition, for all tidal waters, maximum temperature elevation is to be limited as follows:

For natural water temperatures of 50° F., or less, the temperature elevation must not exceed 20° F. above the natural water temperature, with a maximum temperature of 60° F.

For natural water temperature greater than 50° F., the temperature elevation must not exceed 10° F. above the natural water temperature, with a maximum temperature of 90° F.

Any deviation, other than natural, from the above requirements is to be evaluated for risk to the propagation of fish and other acquatic life by the Department of Chesapeake Bay Affairs, and will be permitted or denied by the Department of Water Resources after consultation with that agency.

MASSACHUSETTS

Class A (excellent waters)—no increase other than of natural origin.

Class B (recreational criteria; excellent aquatic life habitat)—no increase except where temperature will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83°F. in warm water fisheries, and 68°F. in cold water fisheries, or in any case raise the normal temperature of the receiving stream more than 4°F.

Class C (good indigenous aquatic life habitat)—same as Class B.

Class D (industrial, power, navigation)—no increase except where temperature will not exceed the recommended limits on the most sensitive receiving water use and in no case exceed 90°F.

All coastal and marine waters—no increase except where temperature will not exceed the recommended limits on the most sensitive receiving water use.

NORTH DAKOTA

Maximum, 93°F. (Red River of the North, Boise de Sioux, parts of Sheyenne and Pembina Rivers).

Limitation, 10°F. plus, on amount of temperature change in the receiving water from wastes of any single source.

Maximum, 90°F. (all other interstate waters). No limit numerically on temperature change; general narrative statement limits harmful effects of wastes.

OREGON

General statement that no measurable increase in temperature allowed when the receiving water temperature is 64°F. or above, or more than 2°F. increase when receiving water temperature is 62°F. or less. The following are exceptions to this general statement:

Multonomah Channel, main stem Willamette River, main stem Snake River: 70°F. and 68°F. respectively in statement similar to above.

Main stem Columbia River, main stem Grande Ronde River, Walla Walla River: 68°F. and 66°F. respectively in statement similar to above.

Marine waters: No significant increase above natural background temperature allowed.

SOUTH DAKOTA

Fisheries:

Cold water permanent—68°F. maximum, 4°F. change.

Warm water permanent—85°F. maximum 4°F. change.

Kar water semi-permanent—90° F. maximum, 8° F. change.

WASHINGTON

Class AA (extraordinary waters): No measurable increases in temperature permitted within the waters designated which result in water temepratures exceeding 60°F. (fresh water) or 55°F. (marine water) nor shall the cumulative total of all such increases arising from nonnatural causes be permitted in excess of t=75/(T-22) (fresh water) or t=24/(T-39) (marine water); for purposes hereof "t" represents the permissive increase and "T" represents the resulting water temperature.

Class A (excellent waters): same statement with the following numerical limits—65°F. and 61°F. maxima for fresh and marine waters respectively. Fresh water formula for increases—$t=90(T-19)$; marine water formula for increases—$t=40/(T-35)$.

Class B (good waters): same statement with the following numerical limits—70° F. and 66° F. maxima for fresh and marine waters respectively. Fresh water formula for increases—$t=10/(T-15)$; marine water formula for increases—$t=52/(T-32)$.

Class C (fair waters): same statement with the following numerical limits—75°F. and 72°F. maxima for fresh and marine waters respectively. Fresh water formula for increases—$t=125/(T-12)$; marine water formula for increases—$t=64/(T-29)$.

WISCONSIN

Fish and other Aquatic Life: In waters where this use is of primary importance, the temperature shall not exceed 84°F. No change from natural unpolluted background by more than 5°F. at any time nor at a rate in excess of 2°F. per hour. Where fishing is desirable in conjunction with other uses, the temperature shall not exceed 89°F. for warm water fish. There shall be no abrupt change from background by more than 5°F. at any time. In addition, authorization must be obtained for proposed installations where the discharge of a thermal pollutant may increase the natural maximum of a stream by more than 3°F.

Streams classified by law as trout waters shall not be altered from natural background by effluents that affect the stream environment to such an extent that trout populations are adversely affected in any manner.

Industrial Water Supplies—Temperature not to exceed 89°F.

TEXAS

For all waters except the Canadian River and tidal waters—Upper limit of the representative temperature—96°F and not to exceed a 5°F rise in the representative temperature above natural conditions.

For the Canadian River Basin—upper limit of the representative temperature—93°F and not to exceed a 5°F rise in the representative temperature above natural conditions.

For Tidal Waters—Fall, winter, and spring, not to exceed a 4°F rise in the representative temperature above natural conditions. Summer—not to exceed a 1.5°F rise in the representative temperature above natural conditions.

(These criteria will apply until a study of stream uses has been made and recommendations set forth.)

MICHIGAN

Domestic Water Supply—The maximum natural water temperature shall not be increased by more than 10°F.

Industrial Water Supply—same as above.

Recreation—90°F maximum.

Irrigation and Stock Watering—not applicable.

Navigation and Power Generation—the maximum natural water temperature shall not be increased by more than 10°F.

(Aquatic Life—not approved.)

ILLINOIS

Public Water Supply—93° F. maximum.

Industrial Water Supply—not to exceed 95° F. at any time.

Recreation—no criteria.

Lake Michigan—(shore water) not more than 85° F., (open water) not more than 85° F.

(Aquatic Life other than Lake Michigan—not approved.)

RHODE ISLAND

Class A (excellent quality)—no increase other than from natural origin.

Class B* (bathing, all uses except untreated PWS)—no increase that will impair assigned uses.

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*The temperature increase shall not raise the temperature of the receiving waters above 68° F. for cold water fisheries and 83° F. for warm water fisheries. In no case shall the temperature of the receiving water be raised more than 4° F.

Class C* (fish and wildlife, recreation)—same as Class B.

Class D (navigation, power, cooling water)—No increase except where the increase will not exceed the recommended limits on the most sensitive water use and in no case exceed 90° F.

Class SA (shellfishing)—no increase over the recommended limits for the most sensitive use.

Class SB (bathing, restricted shellfishing)—same.

Class SC (shellfish habitat)—same.

Class SD (navigation)—same.

MISSOURI

Effluents shall not elevate or depress the average cross-sectional temperature of the stream more than 5° F. The stream temperature shall not exceed 90° F. due to effluents.

Lakes and Reservoirs—temperature not to be increased due to cooling water discharge.

(Exceptions include: Des Moines, White, Current, and Eleven Point Rivers.)

LOUISIANA

Not to be raised more than 3° C. above normal ambient water temperature, nor to exceed a maximum of 36° C.

A few rivers—2° C. rise, 35° C. maximum.

ALABAMA

Public Water Supply—ambient temperature not to rise more than 10 percent after reasonable mixing from effluents, nor shall temperature exceed 93° F. except for 8 hours during a 24-hour period with a normal maximum of 90° F.

Total body contact—same as PWS.

Agricultural and Industrial Supply—same as PWS.

Navigation—no criteria.

VIRGIN ISLANDS

Class A (preservation of natural phenomena)—no change.

Class B (bathing, marine life propagation)—not to exceed 90°F at any time nor as a result of waste discharges to be more than 4°F above natural during fall, winter, and spring, nor 1.5°F above during summer.

Class C (harbors)—no criteria.

TENNESSEE

Domestic Water Supply—the temperature of the water shall not exceed 93°F and the maximum rate of change shall not exceed 3°F per hour. In no case shall the maximum temperature rise be more than 10°F above the stream temperature which shall be measured at an upstream control point.

Industrial Water Supply—same.

Recreation—same.

Stock Watering—no increase to impair assigned use.

Navigation—no increase to impair assigned use.

OKLAHOMA

Differential changes in temperature from other than natural sources shall be limited to a maximum of 5°F provided the maximum temperature due to man-made causes shall not exceed 70°F in trout streams, 75°F in small-mouth bass streams, or 93°F in warm water streams.

CONNECTICUT

Class A (water supply)—no increase other than from natural origin.

Class B (bathing, all uses except untreated PWS)—no increase to exceed recommended limits on most sensitive water use, and in no case to exceed 4°F over natural with a maximum of 85°F.

Class C (fish and wildlife)—same as Class B.

Class D (navigation, power, cooling water)—same as Class B.

Class SA (shellfishing)—same as Class B.

Class SB (restricted shellfishing, bathing)—same as Class B.

Class SC (shellfish habitat)—same as Class B.

Class SD (navigation)—same as Class B.

MONTANA

Public Water Supply (treated)—no increase over natural conditions; (untreated)—not applicable.

Recreation (bathing)—not applicable.

Salmonid Fish:

Increases: 32°F to 67°F—2°F maximum; above 67°F—0.5°F.

Decreases: Over 55°F—2°F max./hr.; 55°F to 32°F—2°F, provided that water temperature must be below 40°F during the winter season and above 44°F during the summer season.

Non-salmonid Fish:

Increases: 32°F to 85°F—4°F maximum; above 85°F—0.5°F maximum.

Decreases: Over 55°F—2°F max./hr.; 55°F to 32°F—2°F maximum, provided that water temperature must be below 40°F in the winter season and above 44°F in the summer season.

Agricultural Water Supply—not applicable.

Industrial Water Supply—no increase that would impair uses.

ALASKA

Public Water Supply—below 60°F; waste flows above 60°F adjusted to ambient receiving water temperature.

Recreation—numerical value is not applicable.

Fish and Wildlife Propagation—may not exceed temperature of natural conditions by more than 5% for salt water or 10% for fresh water. No change permitted for temperature over 60°F. Maximum rate of change—0.5°F.

Shellfish Propagation—less than 68°F.

Stock Watering Irrigation—between 60°F and 70°F.

Industrial Water Supply—less than 70°F.

HAWAII

Classes AA, A, B (all uses of coastal and tidal waters)—temperature of receiving waters shall not change more than 1.5°F from natural conditions.

DELAWARE

Ocean Waters—shall not exceed 5°F above normal for the area or a maximum of 75°F.

Most Rivers—shall not exceed 5°F above normal for the section. (For some rivers—a maximum of 85°F or 87°F.)

OHIO

Public Water Supply—no criteria.

Recreation—no criteria.

Industrial Water Supply—not to exceed 95° F. at any time.

Aquatic Life B (fish passage)—not to exceed 95° F. at any time.

(Aquatic Life A—not approved.)

NEW JERSEY

FW-1-preserve natural conditions.

FW-2 (public water supply)—not to exceed 5° F. increase over natural, up to 87° F. Natural stream temperature above 87° F.

FW-3 (all uses except PWS)—same as FW-2.

FW-4 (some fish life)—no criteria.

(Tidal and Coastal Waters—not approved.)

Delaware River Bay and Estuary—shall not exceed 5° F. above the average daily temperature gradient displayed during the 1961–1966 period, or a maximum of 86° F., whichever is less.

NEW YORK

To: Engineering firms practicing in New York State.
Subject: Thermal aspects of discharges on water resources (Technical Bulletin No. 36).

To protect water resources, fishlife, and stream biota from effects of transient and long-range adverse temperature changes, careful studies of stream environment should be conducted where discharges of thermal significance are contemplated.

Such studies might include, but not be limited to:

(a) Natural background conditions of temperature, ecology, base flow, and physical and biological character of receiving waters

(b) Stream geology, hydrology, tides, currents, and man-made barriers

(c) Climate, winds, critical summer temperatures, and general meteorological conditions

(d) Effects upon assimilative capacity of receiving waters

(e) Stratification of heated liquids

(f) Need for full-channel or part-channel diffusion works

(g) Heat transfer calculations, against environmental factors determined above, to assess magnitude of expected change in receiving water quality.

These factors should be evaluated against the folowing criteria:

Trout waters

No thermal discharges will be permitted to waters classified for trout, stocked with trout, or supporting a naturally occurring propagation of trout, or in upstream reaches of such waters as would cause adverse effects thereon.

Nontrout waters

1. *Mixing zone.*—The mixing zone will be separately determined for each discharge so as to minimize detrimental effects. Fish and other aquatic life shall be protected from thermal blocks by providing for a minimum fifty percent stream or estuarine cross-section and/or volumetric passageway, or establishing artificial fishways where considered necessary.

Generally, the surface water temperature shall not exceed 90° F. within the mixing zone. Consideration will be given to effects of each discharge based on hydrodynamics and other factors of receiving waters.

2. *Outside mixing zone.*—Stream temperatures in excess of 86° F. will not be permitted after mixing. Further, no permanent change in excess of 5° F. will be permitted from naturally occurring background temperatures.

In multiple discharge situations stream capacity to meet such criteria will be apportioned among the discharges.

3. *Outside mixing zone: Fresh surface water classes.*—Temperature change rate shall be limited to 2° F. per hour, not to exceed 9° F. in any 24-hour period, further limited in that for any seven day period the average change will meet the 5° F. change of background criteria stated in item 2 above.

4. *Outside mixing zone: Tidal salt water classes.*—Discharges shall not raise monthly means of maximum daily temperatures more than 4° F. from September through May, nor more than 1.5° F. during June, July, and August.

Temperature change shall not be more than 1° F. per hour, not to exceed 7° F. in any 24-hour period at maximum, except when natural phenomena cause these limits to be exceeded.

Where necessary, cooling towers or other devices must be installed to meet these stream criteria. The State Conservation Department will act as a consultant to the Health Department insofar as fish life and aquatic biota are concerned.

This Bulletin was developed to advise and provide guidance to engineering firms, industries and others of water quality objectives and requirements for thermal aspects of discharges to the surface waters of New York State.

ROBERT D. HENNIGAN,
Assistant Commissioner, Division of Pure Waters.

Mr. CARPENTER. Let's get these other questions on the record.

Have you made any attempt to transfer space or military research results to application in pollution control? What mechanisms do you have to try to use such on-the-shelf technology. What is your experience so far? What would you recommend to improve interagency technology transfer?

In other words, have you gone to NASA or the Atomic Energy Commission and talked with their technology transfer people in terms of specific questions. Or have you asked them what they think they have that you might use?

Dr. **Weinberger.** Dick, we have had some very direct liaison with these people, and I know Mr. Daddario doesn't like the word "liaison."

We have actually carried out a project with NASA in terms of some of the work which they have developed in terms of biological treatment. It was a jointly supported project.

NASA has on our behalf made an analysis of the projects which they have supported in terms of applicable technology. Our people—and remember that our program has in-house capability as well as the extramural support—in-house staff, our research scientists, constantly are reviewing the literature, reports of NASA, DOD, and AEC.

There have been a number of innovations developed by those agencies which we have tried out in our laboratory, which is currently under consideration. Again I can give you some examples of this.

Some of the work done on identification of micro-organisms is part of the space program, where they need rapid methods for measuring pathogenic organisms. These obviously have an application to our field.

The analytical techniques that are developing, the methods which they are employing for some of the space work has a direct application. As a matter of fact, our requirements are usually considerably less stringent than the space program, because we do not have their space and weight restraints.

Mr. **Carpenter.** Have you translated your requirements into the terms of the technology that might be needed, or have they come to you with possible things that they have seen? Maybe it has gone both ways.

Dr. **Weinberger.** It has gone both ways. We of course continuously indicate what our needs are. In the case of AEC, as an example, there has been continuing direct liaison between the Commission staff and ours and their laboratory staffs and ours where we specifically pinpoint some of our needs for pollution control equipment.

Mr. **Felton.** Do you contract with any other Federal laboratory for the performance of work related to pollution?

Dr. **Weinberger.** Yes. A transfer of funds I think is more the term, but some of these agencies do work for us.

Mr. **Felton.** Could you put in a background statement on what this involves?

Dr. **Weinberger.** It has been limited, but I will get the indication of what these have been.

I might say again in answer to the question, it worked both ways. We have done some work for other agencies in terms of pollution control, and one of the projects we had was trying to determine the quality of recycyled water for a reuse system.

(The information requested is as follows:)

REIMBURSABLE WORK PERFORMANCE BY OTHER AGENCIES

	Fiscal year 1967	Fiscal year 1968 estimate	Expenditures as of Mar. 26, 1968	Fiscal year 1969 estimate	Purpose
U.S. Geological Survey—Acid mine drainage (0840).	$150,000	$100,000	....	$20,000	Acid mine drainage studies.
U.S Geological Survey—Estuarine (Corvallis) (9841).	450	900	....	1,000	Estuarine, flow gauge.
U.S. Geological Survey—(Newtown) (4884)	....	19,000	....	....	Construct weirs.
U.S. Geological Survey—Eutrophication (Ely) (5883).	....	10,000	$4,000	8,000	Stream gauging.
Bureau of Mines (0840)	486,400	170,000	100,000	....	Acid mine drainage studies.
Sports, fish and wildlife (0840)	50,000	75,000	17,700	....	Do.
Alaskan Air Command, U.S. Air Force (9842).	....	12,000	8,000	....	Pilot treatment plant, co-op.
Total	686,850	386,900	129,700	29,000	

Mr. Carpenter. The AEC reminds me of this one specific. In the large nuclear desalting plant that is now being considered, has there been a study of the effect on marine ecology of the salt and hot effluent?

Dr. Weinberger. John, I think you called on that one.

Mr. Barnhill. Yes, I called Jack Hunter, Director of the Office of Saline Water, and he furnished me with this statement. You may have this.

He tells me that there have been extensive cooperative studies with the Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife in this Department on possible ecological effects of the thermal discharges from that plant. He is of the opinion that they have the problem well in hand.

Mr. Carpenter. And that Fish and Wildlife agree with that opinion?

Dr. Weinberger. Yes.

(The document referred to is as follows:)

Subject: Discharge of Effluent From a Large Nuclear Electric Power and Desalting Plant

OSW has always been concerned about the possibility of degrading the marine environment through the discharge of the waste brine and cooling water from desalting plants. The Bureau of Commercial Fisheries and Fish and Wildlife Service of the Department of the Interior have been consulted within this matter and several studies have been made by the Office of Saline Water to investigate the hazard that might be presented to the marine ecology through the thermal effects, salinity concentration, and other contaminants that might be contained in the discharge. The most recent study made by the Dow Chemical Company for OSW in conjunction with the Texas A&M University was completed in September 1967. This study investigated the effects of a plant of the same size and type as the MWD plant on the marine environment utilizing the specialized talents of these two organizations and the available pertinent literature including reports by the Atomic Energy Commission, U.S. Public Health Service, California State Water Pollution Control Board, Department of the Interior, etc. Also meetings were held with cognizant Department of the Interior personnel including Commercial Fisheries and Fish and Wildlife to obtain additional information for the study, and they are in agreement with our approach and recommend bio-assay surveys during plant operation.

An important fact which should be brought out in connection with a study such as this is that the effluent from a large nuclear dual-purpose power-desalting plant comes from three sources—the concentrated brine blowdown, the cooling water from the desalting plant, and the cooling water from the power plant. In a plant the size of MWD with a concentration ratio of about 2, for every gallon of potable water produced, approximately one gallon of brine at twice the salinity of normal sea water and at a temperature of about 12° F above ambient will be discharged. However, about 15 gallons of other sea water used for cooling the desalting plant and power plant, at the same salinity and about 12° F above ambient, will also be discharged. Combining these discharges will result in a composite effluent only slightly above the ambient salinity and about 12° F above ambient temperature. Thus, the discharge from a plant like MWD should present no more of a hazard to the ecology from a salinity and temperature standpoint than the discharge of cooling water from a large power plant due to the high dilution of the waste brine effluent from the large amount of cooling water required.

During the operation of a desalting plant small amounts of chemicals are sometimes introduced into the feed water for scale control and are contained in the discharge along with small amounts of other corrosion products picked up in the plant. The effects of these small perturbations on the effluent have been, and will continue to be, studied and monitored through bio-assays made prior to and during operation of various desalting plants. This has been done at the San Diego Test Facility. Further, by proper design and location of the effluent outfall other factors of safety can be added to negate any possible harmful effects to the ecology.

Mr. CARPENTER. The final question——

Dr. WEINBERGER. Let me just add one sentence to that. Again, even more effective communication is nonetheless warranted, and here you run into the problem of the amount of time that you do spend on liaison and coordination in getting your story across.

I would say that there is a good degree of exchange. I might say that steps are being taken in the executive branch to improve communication, with information storage and retrieval systems.

Mr. CARPENTER. This is right within one department. That is one of the reasons for our question, is whether on these complex subjects of ecological effects you had experience in your department here any conflict that required resolution. And this statement, then, in your answer, would indicate that you have had the OSW and Fish and Wildlife together, and they have agreed that the situation is——

Mr. BARNHILL. Well, we haven't done it, but they have gotten together within the department and apparently from that statement, and my conversation with Dr. Hunter——

Mr. CARPENTER. But you would cover these coastal waters?

Dr. WEINBERGER. Yes.

Mr. CARPENTER. The final question: In air pollution the law now calls for registration of fuel additives, not to show that they are safe or unsafe, but to simply alert the Surgeon General that these new chemicals might be entering the environment.

Would you advocate a similar law for effluents to surface waters, should industry or Government be responsible for forecasting or anticipating ecological effects of new effluents?

Dr. WEINBERGER. I will ask Mr. Barnhill to take a crack at that one.

Mr. BARNHILL. Well, the law does not now, at least not the Federal Water Pollution Control Act, require the registration or announcement of new chemicals or new wastes. This is obviously something that we discussed, and we were particularly concerned at the time with pesticides. And this was while we were in the Department of Health, Education, and Welfare. And we actually proposed that this needed to be done, but we ran into the difficulties that you would normally expect to, and that would be that we were encroaching on someone else's jurisdiction, and of course opposition from industry.

Mr. Carpenter. You mean USDA?

Mr. Barnhill. Yes, it was USDA. And of course industry would oppose, as they always have, and if I were in indsutry I would do the same thing. But they oppose it.

We still think it is a good idea.

Mr. Felton. Was the section of your act which says in effect that industry does not have to divulge trade secrets or secret processes in the act from the beginning, or was this added sometime along the way?

Mr. Barnhill. When was it added?

Mr. Moore Was it in the original act or has it been added since?

Mr. Barnhill. It has been added since. I don't remember that it was in the original 1956 act at all. I think this was in the 1966 amendments.

Mr. Felton. So this was subsequent to your push to get this type of registration?

Mr. Barnhill. Yes.

Mr. Felton. Which pretty well closes the door on——

Mr. Barnhill. Well, except for one thing. First let me answer the last part of the question. We think industry should be responsible for defining the potential or actual toxic effects of any material that they supply that will find its way in the water as a pollutant. At the same time I think this infers that we would do enough work of our own to be able to monitor what industry is telling us.

Now I have forgotten what you just asked me.

Mr. Felton. Well, this section would preclude you ever seeking registration.

Mr. Barnhill. No; I don't think it would, because they register, they are required to register under other acts these proprietary chemicals, you see. They get a patent on them. So once they have refined and are ready to produce the material, it becomes——

Mr. Felton. A trade secret by definition is not patented. Normally trade secrets have to do with that which is not patentable.

Mr. Barnhill. Yes; but they don't have to tell us how they manufacture this product. They only need to tell us what this product does to the environment. You see the trade secret would be in how they produce this material.

Mr. Felton. Or what is in it.

Mr. Barnhill. Well, any good chemist, I think, could eventually tell you what is in any of these.

Mr. Carpenter. Well, I am thinking of the responsibility that you might see in new refractory organic materials that are being synthesized if not produced at a high rate, thousands per year, as to the feasibility of doing ecological studies on these chemicals, but the still substantial chance that they might turn up in effluents.

Dr. Weinberger. If I can, again let me add onto what John Barnhill said. I would say that it is a joint government-industry responsibility to develop test procedures by which new chemicals, new products, may be evaluated for their pollution potential, and this has been a role which we have had and we have worked rather satisfactorily with industry. We worked with them in terms of coming up with a biodegradability test. We currently are working with them trying to develop what we call an algal growth potential test. We have done quite a bit of work in terms of measuring how the acute and chronic or long-range effects on fish and aquatic life. We are getting more sophisticated in trying to develop ecological chambers, so you can measure the ecological effects.

Incidentally, we are a long way from being able to do that. I am not even suggesting that we will be able to do this in the near future, and as John points out, at the same time we have got to have the analytical capability to measure these materials.

But here again I think we have to put added responsibility on the industry, when they come up with a new product, to begin requiring them to develop analytical techniques. Incidentally, this is not too different from FDA.

We, of course, would be completely overwhelmed, and I don't think it is a proper Government role, to evaluate every new product under every possible circumstance.

Mr. Moore. Well, it seems to me this is one of the points at which the practical considerations would have to have some weight. I see no point in requiring a series of registrations or a series of reports or a series of analyses if all you are going to do with them is file them somewhere.

It seems to me some thought would have to be given before you could commit yourself on a program of this scope.

Dr. Weinberger. That is right.

Mr. Moore. I think you would have to give some consideration to what might be required of FWPCA if you were going to do something with them, before you answered the question as to whether they ought to all be just routinely filed.

Now it seems to me that the question I believe you were getting at is one that might be more pertinent, and that is there could be something in the effluent that would not necessarily be in the end product that could be more dangerous than the end product was

Mr. Carpenter. That is right.

Mr. Moore. It seems to me that in any event the primary responsibility for what gets in the effluent has to lie with the industry, because this could happen if the reporting process were working.

Mr. Carpenter. Yes. The primary responsibility would have to lie with industry, to be sure, as it proceeds, it does not come in conflict with the standards or criteria that have been established by the FWPCA.

Mr. Barnhill. I hope Dr. Weinberger will agree with you—at least I feel we can work with industry and develop a screening test that would be short and reliable and would very quickly dispense of 95 percent of these chemicals, and then we could develop test procedures——

Mr. Carpenter. Yes.

Mr. Barnhill (continuing). For whatever the remaining amount would be, without too much difficulty.

Mr. Felton. Are you doing anything along this line now?

Dr. Weinberger. Oh, yes.

Mr. **Barnhill.** Well, yes.

Dr. **Weinberger.** Most of your test procedures for assessing the long-range effect on fish and aquatic life, these testing procedures were developed by biologists at our laboratories. Many of these toxicity tests were developed or the procedure——

Mr. **Felton.** No, I mean is industry now voluntarily submitting its products to you for assessment.

Mr. **Barnhill.** No.

Dr. **Weinberger.** No.

Mr. **Carpenter.** That is it.

Mr. **Felton.** Gentlemen, once again we thank you.

(Whereupon, at 3:35 p.m., the committee recessed, subject to call.)

APPENDIX B

Communications to the Subcommittee on Science, Research, and Development

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SMITHSONIAN INSTITUTION,
Washington, D.C., April 2, 1968.

Hon. EMILIO QUINCY DADDARIO,
Chairman, Subcommittee on Science, Research and Development, House Committee on Science and Astronautics, House of Representatives, Washington, D.C.

DEAR MR. DADDARIO: I am pleased to respond to the invitation to participate in your Subcommittee's hearings on environmental quality. In an effort to provide a useful contribution, I have prepared the attached statement for inclusion in the record. The first section of the statement provides a description of the conceptual framework within which those activities of the Institution that have a direct bearing on the issues of environmental quality are evolving, together with a brief inventory of some of the relevant, ongoing programs.

The second part of the statement represents an attempt to gain a coherent overview of the numerous proposals that have emerged in response to the need for institutional mechanisms capable of developing an understanding of the interrelationships between human societies and the sustaining environment.

It is our belief that the problems which create the need for such mechanisms require no further documentation. We must now concentrate our efforts on reaching agreement concerning the most comprehensive and positive way in which to proceed. The second part of our statement is an outline of what we feel is necessary.

You are to be congratulated for your foresight in recognizing the significance of the problems that exist in the area of environmental quality. By providing a forum for an exchange of views on this topic, you are performing a most important service to the nation. I commend your efforts and look forward in assisting you in any way possible.

Sincerely yours,

S. DILLON RIPLEY,
Secretary.

STATEMENT BY S. DILLON RIPLEY, SECRETARY, SMITHSONIAN INSTITUTION

Mr. Chairman and members of the Subcommittee, I am pleased to participate in these hearings on environmental quality.

In order to provide you with the conceptual framework within which the Smithsonian Institution is evolving its program in ecology, I would like to insert a statement that was prepared for our Board of Regents.

For the average citizen, ecology is fast becoming a household word, as increasingly it is being demonstrated to him that man is in nature and is a part of nature. No longer can he regard himself simply as a separate creation divinely appointed to manipulate nature at will. He now begins to understand that a human society with its total environment functions as an integrated whole in nature—that is, as an ecological system, or ecosystem.

He sees, moreover, that with his modern technology man is capable of massive environmental manipulations that were unimagined even a few years ago; and because he is told that such changes are usually irreversible and can adversely affect the lives of future generations as well as his own, he now senses the importance of seeking scientifically valid means of predicting the consequences of any alteration in the ecosystems of the world.

He begins to recognize, in short, that he must increase his scientific understanding of whole ecosystems, taking man as an essential component, if he is to establish a viable basis for the cultural and intellectual development of human society. Leading humanists, scientists, and Congressmen have for some time been keenly aware of this, and of the adverse ecological changes occurring throughout the world today, and they express mounting concern lest the quality of human life deteriorate to an unbearable degree through improper management of the environmental systems which sustain it.

We openly admit that unstable relationships between man and his total environment have formed and that under the twin pressures of an expanding economy and of excessive self-constricting population growth, competition for the finite resources of the earth almost inevitably results in their misuse.

Having accepted the fact that human society is an integral part of the earth's ecosystems and that the resources of its environments are limited, when then must we do? If the critical problem facing humanity today is the ecological one of harmoniously relating human societies to sensitive environments of finite scope and potential, we are forced to conclude that the growth of human society must henceforth be measured mainly in terms of quality rather than of quantity. The problem, in its most restricted form, lies within the domain of the natural sciences. Indeed, from one point of view, we can regard ecology as the most recent scientific outgrowth of natural history. But in its most general form the problem involves all the dynamics of man-in-society. Here it is that ecological principles are confronted with those of economics, political theory, law, and education—indeed, with all the institutions and organized structures of knowledge that deal significantly with the social reality. Clearly, the problem is too intricate and too important for the ecologist alone to solve.

Putting in perspective the present destructive influences of man on his environment, and ultimately on his own society, requires a new approach involving a synthesis of relevant knowledge from the humanities and behavioral sciences as well as from the natural sciences. Eminent contemporary intellectuals have already pointed out that we need a new science; ecologically oriented but not ecology in its traditional sense. The subject matter of the new science is human society and its total environment. If we think in terms of levels of biological integration—the molecular, cellular, organismal, population, community, and community-plus-environment levels, then we must regard the highest and most complex level as that dealing with the human dimension, where human society and its containing environment exist as a functioning whole in nature. We have seen that near the bottom of the spectrum, in molecular biology, spectacular advances in our understanding of the genetic code have resulted from the integration of ideas found in chemistry, physics, mathematics, and biology. Can we expect anything less exciting and significant to grow out of our concentration upon the highest levels of organization, at the other end of the spectrum, where the penalty of ignorance may well be irreversible and devastating change?

The challenge is enormous and the difficulties immense. In view of the complexity that presents itself, even at the lower levels of biological integration, the task of building a conceptual structure that would enable us to deal effectively with the upper regions of the spectrum, and with the spectrum in its entirety, seems almost overwhelming. Some have remarked that the highest ecosystem level is not more complex than we think it is, it is more complex than we *can* think.

Yet the problem is often one of perspective; and if we are to face our work squarely, we must make every effort to rid ourselves of that form of cultural near-sightedness which obscures the total design of the canvas even while it brings the details into focus. For example, the cycling of radioactive particles or pesticides through plants and animals into man—who released these destructive contaminants in the first place—is an ecosystem phenomenon, the attributes of which involve decisions in the minds of men as well as the physical movement of these substances through the air, water, soil, and living organisms. Thus, recognizing that human values and the motivating forces of economics and politics can contribute directly to the structual and functional characteristics of ecosystems in which man is the dominant force, it is clear that one must direct thought and research toward searching out the unique and possibly controlling phenomena—in this case, man's cultural behavior—that operate at whatever level in nature is under study.

Within this broad context of the search for solutions to contemporary ecological problems relevant to or embracing modern society, the Smithsonian program in ecology is evolving. Its primary goal is to advance basic ecological theory at all levels of biological integration, but its emphasis is upon the largely unexplored higher levels—on such areas as populations and communities of animals, on vegetation as a structure or pattern of plant communities, and on communities-plus-environments as total ecosystems. It seeks particularly to study ecosystems that are least modified by man. These are natural complexes, which are self-maintaining when human interference does not intrude upon the regulatory processes enough to cause the system to deteriorate, and they can therefore provide the means to understand and measure the effects of such interference. This type of undisturbed area is becoming increasingly rare in our day, and without protection from man's activities it will soon disappear.

The Smithsonian program of ecology also, therefore, encourages and practices conservation, which has two aspects—the aesthetic and the scientific. With the aesthetic aspect all are familiar; the arguments in favor of preserving unmolsted the beauty of the land elicit something like a conditioned reflex, and we dutifully nod approval. But with the other side of the coin, the scientific values of conservation, we are much less familiar. From a scientific point of view, conservation means preserving the capacity of ecosystems to support rich and varied forms of life. This is a matter of biological necessity if we are to maintain a diversity of environments in which it is not only possibly to live but also in which it is worth living. The natural area, so-called because the works of man are not significant elements in its composition, is an outdoor laboratory and, as such, it is the only apparatus by which we can gauge the changes that occur in the regions dominated and modified by man. These reserves are the only frame of reference we have. In them we can make observations with a minimum of disturbance, or carry out controlled and carefully recorded environmental manipulations to determine how ecosystems actually function in nature. This sort of research contributes to our ability to predict the consequences of man's alteration of his environment.

The Smithsonian Institution encourages, and aids where possible, the establishment of natural areas for research, education, and a means of communicating ecological ideas to society. The Chesapeake Bay Center for Field Biology, under the administration of the Office of Ecology, reflects this interest and activity. Such areas must be under the best protection that society can provide through its laws and institutions; and the 120 years of Smithsonian tradition in preserving objects of cultural and scientific importance provides assurance that natural areas, which might be thought of as outdoor museums, will be saved in perpetuity for science and society.

While emphasis is placed on the higher orders of biological integration and on the conservation and study of natural ecosystems, the Smithsonian ecology program also includes species-oriented ecology, and the biological problems related to urban development are not excluded. And although research is given priority, the ecology program is also deeply committed to education and to the diffusion of sound ecological information throughout society. In this sphere its efforts are directed toward constructing a conceptual framework, drawing upon the humanities, the behavioral sciences, and the natural sciences, that will enable man to deal purposively with his world on the level of human society-plus-its-total-environment. To gather these strands together, research is being linked with university education at home and abroad, and contemporary ecological thought is being transmitted through lectures, seminars, and publications.

If we accept the thesis that advancement of scientific theory about ecosystems and man's place in these systems is oriented primarily around the understanding of how they actually behave in nature, then with sufficient knowledge about how ecosystems work, we may be able to manage them in the best interests of society by manipulating the controlling (or regulatory) processes. Increasing our understanding of how an ecosystem works requires two general types of research.

One type of research is concerned with basic descriptions: (1) of the physical, chemical, and biotic components of the system; (2) of the structural and functional relationships of these components to each other and to the system as a whole; (3) of the variations of the system in time and space; and (4) of the environmental relationships of the system to other ecological systems. The total systems approach, embracing climate, soils, hydrology, vegetation, and animal life—including man—provides a foundation for studies of regulatory processes.

These basic descriptions require a solid foundation in the taxonomy of the species components; precise identification of plants, animals, and other organisms is fundamental to the advancement of ecological theory. Basic descriptions, also include preliminary interpretations.

These concern, for example, the ecological interrelationships of the component populations, the cause and effect of changes in vegetation and its associated animal life through time, or the influence of upwelling ocean currents on the productivity of marine life—and in turn they often generate ideas for further studies on the functions and processes of ecosystems.

As was pointed out earlier, ecology is sometimes said to be the scientific outgrowth of natural history. In the ecology program of the Smithsonian a strong foundation for research concerned with basic descriptions is provided by the vast collections and the enormous bank of taxonomic knowledge in its Museum of Natural History, a bank to which the Smithsonian has contributed for over 100 years through its expenditions into the "virgin" areas of the Western States, the Arctic regions, the Tropics, and elsewhere throughout the world.

The massive task of curating the collections from these expeditious leads naturally into systematic and evolutionary biology, and as a consequence, taxonomists have often become so specialized in the systematics and biogeography of their own particular group of organisms that they have had little time or inclination to explore the significance of ecological studies. Ecologists, on the other hand, have often tended to underestimate the importance of these basic descriptions and the significance of systematic biology and ecology at the species level. A related objective of the Smithsonian ecology program is, therefore, to bridge the gap that has developed between systematics and ecologists and to renew the close relationships that formerly existed between these two disciplines. Obviously, such interdisciplinary integration is essential if we are to increase our knowledge of how ecological systems work in nature.

The second type of research required to increase understanding of how ecosystems work is concerned with interpretive, ecosystem-oriented studies rather than basic descriptions. Examples of such studies would be: (1) the role of social behavior or the significance of predator-prey relationships in the numerical regulation of animal populations; (2) the principles of vegetation change; (3) the flow of energy through the system as expressed in rates and amounts of primary and secondary productivity; (4) the cycling of mineral nutrients; or (5) the consequences of man's environmental manipulations. These examples point the direction in which the new quantitative ecology is developing. These are the studies at the higher levels of biological intergation, although usually below the level of human-society-plus-environment, that excite ecologists intellectually.

To sum up: the Smithsonian program in ecological research embraces both basic descriptions and ecosystem-oriented studies. It emphasizes studies of significance to both ecological theory and to the understanding of man's place in nature. Its aim is to form a small group of scholars, each of whom will advance knowledge significantly in his own specialty—be it vegetation science, animal behavior, the dynamics of animal populations, or the energetics of ecosystems—and who will also help construct a new interdisciplinary framework that will enable us to assemble a broad spectrum of knowledge relevant to the current ecological problems of our society. By this means, it is hoped, a viable scientific basis can be established for maintaining and improving the quality of man's environment.

In this challenging new era of multiple, competing demands and shifting perspectives, the Smithsonian Institution, as a privately endowed organization with strong governmental relationships, serves as an important focal point for both national and international programs in basic research and education in ecosystem-oriented ecology.

Within this context, Mr. Chairman, I should like to refer briefly to those elements within the Smithsonian Institution that have a distinct bearing on its capability to contribute to the qualtiy control of our environment.

The Museum of Natural History is an international center for the biological specimens in the nation. The interests of the museum include all aspects of the natural sciences. Anthropology, botany, entomology, invertebrate zoology, mineral sciences, paleobiology, and vertebrate zoology are well represented. The scientific program of the museum consists of the efforts of over 100 research scientists. Although most of the research is collection-based, it also involves field observation and refined laboratory techniques. The ongoing investigations reflect a considerable diversity of interests, largely within the areas of systematic biology and biogeography. Studies of autecology and physiology are pursued primarily as pathways for determining phylogenetic relationships. The 50 million specimens provide not only a documentation of organisms in space and time but also information indispensable to the understanding of speciation and ecological relationships. Thus the Museum of Natural History provides a strong taxonomic foundation for ecosystem-oriented science.

The Information Systems Division of the Smithsonian is now in the process of computerizing the information on biological and mineral specimens. The development of computer-supported systems will enable the Smithsonian to manage better its information resources and to respond to inquiries with speed, accuracy, and completeness. It also provides increased capability for mathematical and statistical approaches to research, mathematical modeling, and the classification of plants and animals by numerical taxonomy. The Smithsonian's computer capacity is sufficient to initiate storage of ecological information pertinent to contemporary problems of environmental alterations.

The Smithsonian Tropical Research Institute (STRI) has been a component of the Smithsonian since Barro Colorado Island was transferred to the administration of the Institution in 1946. Barro Colorado provides opportunities to study tropical jungle (more precisely, lowland seasonal humid forest) with its characteristic community of animals. The Smithsonian Tropical Research Institute has also acquired a small tract of land on the mainland of the Canal Zone, in the "Navy Pipeline Reservation." It has, in addition, made arrangements to use areas in other parts of the Canal Zone, and the Republic of Colombia in the near future. These circumstances will permit scientists to study in different types of lowland forest, montane forest, alpine moor, grasslands, scrub, and marsh. It will also permit them to make experimental modifications of environments. Its status as a reserve precludes this activity on Barro Colorado. Two marine biology stations have been established in the Canal Zone, one on Naos Island on the Pacific coast and the other on Galeta Island on the Atlantic coast. The focus of marine research is primarily concerned with the evolution of isolating mechanisms in species pairs of marine shore fishes.

The objective of these studies is to determine the actual correlation btweeen types of isolating mechanisms and factors such as morphology, time, geographic separation, competition, and ecology. The terrestrial dimension of research activity at STRI has been primarily zoological. Emphasis has been on problems concerned with biological processes that can be studied best in the tropics, particularly the causes for high species diversity and the social behavior of certain groups of animals (notably anurans, birds, and primates) as they are related to the complexity of tropical communities.

Our Radiation Biology Laboratory conducts research on the functions of living organisms that are affected and controlled by solar radiation. The sun is the principle source of energy for life on the earth. Radiant energy from the sun is trapped by pigments and converted into potential chemical energy. The research of the RBL is directed toward understanding the cellular and subcellular mechanisms and processes by which organisms use radiant energy for their growth and development. Such studies produce information fundamental to the development of technological advances and applications, especially in food production and environmental control. The modern fields of biophysical physiology and biochemistry have a continuing requirement for a precise characterization of solar radiation in developing experiments of health-oriented importance to man. The physiological studies of the RBL provide, as in the case of the Museum of Natural History, an important foundation for ecosystem-oriented studies.

The Office of Oceanography and Limnology operates the Smithsonian Oceanographic Sorting Center which processes marine specimens from national and international expeditions for use by scientists of the world in specimen-related research. The office also facilitates the productive involvement of Smithsonian scientists in aquatic research of national and international significance, and provides outside scientists and research organizations with a focal point for their effective use of Smithsonian competence. Through its Sorting Centers in Washington, D.C., and in Tunisia (the latter principally supported by the Smithsonian Foreign Currency Program), the Office serves as a substantial producer and repository of biological and geological data for the Federal Government. These data are used in the evaluation and harvest of fisheries and mineral resources; in the resolving of naval problems of fouling, bioluminescence, and bioacoustics; and in studying the effects of pollution on the marine environment. The Office of Oceanography and Limnology is concerned with marine ecological studies as well as systematic biology, and coordinates its efforts closely with those of the Office of Ecology.

The Chesapeake Bay Center for Field Biology, which is administered by the Smithsonian Office of Ecology through a consortium arrangement with the Johns Hopkins University and the University of Maryland, provides a relatively stable baseline against which to compare other ecological systems in the rapidly changing Washington area. The Center lies about 7 miles south of Annapolis, Maryland. Its 700 acres of land include areas still in cultivation, areas abandoned from agriculture for 22 years, and areas of relatively undisturbed mature forest. Control of about 10 miles of undeveloped shoreline (the largest such expanse on the western shore of Chesapeake Bay) provides opportunities for long-term studies of salt marshes, eroding bluffs, sandy beaches, and shallow estuaries. Under Smithsonian ownership, the land and surrounding estuaries are preserved effectively for a program of studies extending indefinitely into the future. The objectives of the Center must be viewed within the larger context of the overall program of the Smithsonian Office of Ecology, a central concern of which is to advance scientific understanding of the functional design and processes of ecosystems as a basis for predicting the ecological consequences of man's alterations of natural systems. The research objectives at the Center are: (1) to develop a baseline of knowledge about the composition and structure of terrestrial and estuarine ecosystems at Chesapeake Bay, (2) to conduct specific research relevant to the functioning of ecosystems, and (3) to conduct biosocial studies. In addition to the research objectives, the Center is concerned with the education of young scientists and technicians to meet the critical shortage of manpower required to cope with problems concerning the quality of man's environment. A third goal of the Center is to make information from scientists and other authorities available to the public, particularly on environmental conservation and on social issues as they apply to environmental quality.

A Center for the Study of Short-lived Natural Phenomena was established in response to the recognition that most scientists, including those at the Smithsonian, were missing opportunities for studying the critical early stages of important geological, biological, and meteorological events. The Center, utilizing the excellent facilities and procedures established by the Smithsonian Astrophysical Observatory for the worldwide exchange of information about astrophysical occurrences, has expanded on the SAO system to include events of interest to the other sciences. During the first 2½ months of its existence, the Center has been extremely active in mobilizing activity on such events as the Tonga Island Volcano, the Desception Island Volcano, and oil spillage from damaged tankers. It is anticipated that as soon as funding can be provided, the Center will operate on a larger scale.

The Smithsonian's interests in environmental studies are international as well as national. Representative of our international program are the following projects.

The Island of Dominica in the West Indies has been the site of a program of field studies, based on a rotation of scientists from various disciplines, since January 1964. To date at least 55 investigators, including systematic biologists and anthropologists from universities, as well as from the Smithsonian, have participated in the study. Floristic studies are being published in the *Contributions from the United States National Herbarium* and faunistic studies are being published in the *Proceedings of the United States National Museum.* It is intended that intensive ecological studies be undertaken, based on the data that have been accumulated throughout the survey.

At Belem, Brazil, the Smithsonian is engaged in a cooperative venture in studies of tropical biology at the Guama Ecological Area (APEG). The objective is to bring together in one place the special research talents of a variety of persons and institutions to the end that a comprehensive program of study will emerge, leading to a better understanding of the ecology of the Amazon rainforest and the biology of some of its more important component species. An integrated study of a specific area of equatorial rain forest has never been attempted before on the scale proposed for APEG.

In Korea, a long-range program of research has been initiated, using as an ecological baseline a study area immediately south of the Demilitarized Zone. This area has been rigidly protected over the past 15 years, and provides a key to understanding man's impact on Korean environments. Preliminary studies have led to a proposal for a Korean Center for Environmental Studies, within which an integrated program of research and education in ecosystem ecology can evolve. The design of this program is intended to incorporate into its structure provisions for the accumulation of significant data, for growth of ecological theory, for the strengthening of cooperation within the international scientific community, and for the diffusion of modern ecological thought within the Republic of Korea. The program represents an opportunity to develop some of the basic scientific information Korea requires in its efforts to become self-sufficient.

In Ceylon, under the Smithsonian Foreign Currency Program, a cluster of research projects has evolved, including studies of the behavior and ecology of elephants, studies of Ceylonese flora and vegetation, and investigations of the behavior and ecology of primates. These integrated studies will provide a foundation for conservation practices that are compatible with the development of forestry and agricultural resources. With these projects as a nucleus, the potentialities for a Ceylonese Center for Environmental Studies now exists. All of these projects are being carried out in cooperation with faculty and students at the University of Ceylon.

The concepts and activities described in the preceding paragraphs indicate the manner in which environmentally-oriented studies are being pursued at the Smithsonian Institution. I should now like to discuss those important issues before your Subcommittee that concerns the response of our society to what has been termed the ecologic crisis.

As you have frequently recognized, Mr. Chairman, one of the critical requirements of this nation is for mechanisms which will foster a more adequate understanding of the relationships between society and its total environment. In its report on Environmental Pollution, issued October 21, 1966, your Subcommittee reached several conclusions relevant to our present discussions. It is useful to quote some of these at length:

* * *

> Considering the powerful forces for ecological change which are at man's disposal, admitting the impossibility of complete foreknowledge of the consequences of many activities, and granting that a highly technical, overpopulated world must continue to take risks with natural resources, an "early warning system" for unwanted consequences is extremely important. We do not have such a system at present.

* * *

> Firmly established criteria and standards for environmental quality are necessary to give industry a basis for planning and action.

* * *

> Federal Government scientific activities are not yet channeled to support announced goals in pollution abatement. There is no organization or coordinating group capable of systems analysis

and broad management of Federal projects. Insufficient funding has made support of research spotty and disproportionate among problem areas. Agency missions may inhibit long-term and comprehensive ecological studies. "Pollution" can cover an enormous variety of Federal agency programs ranging from water resources research to agricultural engineering. Limitations of definition will be necessary for effective program coordination.

These and other conclusions which can be reached about our capability to understand the complex interrelationships of society and the environment have generated a flurry of proposals aimed at remedying various aspects of the problem. It is my view that we must now examine all these proposals to identify those elements that are essential for a coherent and realistic national program. Our own attempt to achieve an overview has resulted in the conviction that an integrated three-part approach is necessary. It is my hope that the presentation which follows will contribute in a meaningful way and help bring the dialogue into focus.

I. NATIONAL ASSOCIATION OF REGIONAL CENTERS FOR ECOLOGICAL STUDIES

The expansion of human population and onrush of technology, two phenomena long in developing but only recently the items of widespread concern, are causing us to reassess man's role as a component in the systems of nature. Repeated testimony, before your Subcommittee and elsewhere, gives clear evidence that many of our activities are changing the environment in fundamental and profound, but often unknown ways. Unfortnuately, this realization is generally produced through a painful process of hindsight, and yet the development of principles sufficient in depth and scope to predict the consequences of many decisions that face us lags well behind our growing recognition of their need. Perhaps the central challenge of our times is to provide the understanding that will enable us to establish and maintain harmonious relationships between human society and its rapidly changing environment.

In large part the failure to achieve an adequate understanding of these matters stems from man's tendency to separate, and treat as independent, various aspects of the natural system. In a most extreme pattern man considered himself apart from nature. Examples of more subtle patterns are found in the consideration of animals apart from plants, cities apart from rural areas, energy apart from pollution, and many other erroneous distinctions.

We now know, although only in the barest essentials, that all of the living and nonliving components of the natural system, including man, exist in an interrelated, web-like relationship, and that an unfavorable alteration of one strand in the web may have profound effects on the system as a whole.

Institutional mechanisms directed at achieving an understanding of the ecosystem and making it relevant to public activity are lacking in our social organization. The structural weakness of the I.B.P. is a case in point. We must tap the intellectural resources at our disposal, principally in universities and research laboratories, and develop a process which will make possible the interdisciplinary study of ecological systems. The Smithsonian Institution feels that these resources are presently available in adequate, although minimal, strength—and that a framework must be developed within which they can function.

To create this framework we advocate the establishment of a non-mission-oriented, neutral, independent organization which, through the development of a national network of research centers would:

(1) Develop an integrated foundation of knowledge in ecosystem science, with emphasis on society and its total environment.

(2) Establish an ecological information storage and retrival system.

(3) Stimulate education and training in ecosystem science.

(4) Perform advisory services regarding the ecological impact and consequences of proposed action programs affecting man's environment.

(5) Disseminate ecological knowledge as a basis for the harmonious development of human society and its sustaining environment.

It is to be stressed that only with independence can the resources that exist in the universities and private sector be fully utilized and the all-important goals of synthesis and objectivity be achieved.

One working model for the creation of an organization meeting these standards has recently been proposed by the Ecological Society of America (ESA) in its testimony and submited statement before this Subcommittee. The Smithsonian Institution agrees in principle with the concepts outlined in this presentation, but believes that the ESA proposal must be developed and expanded, particularly in terms of integration between the public and private sectors.

If a regional pattern of university-based consortia is to be successful, it will inevitably require substantial financial and technical assistance from both the federal and private sectors. It is therefore necessary that the organizational structure provide for intimate cooperation among universities, federal agencies, industry, private foundations, and other relevant organizations. Cooperation of this nature is essential for the rapid advance of ecological knowledge which must underlie the quality control of our environment.

We are convinced that the programs and resources of the Smithsonian are extremely relevant to the objectives of a national program in ecosystem ecology. Throughout its history the Smithsonian has played an important role in the genesis of many new organizations. It has served as the spawning ground and home in adolescence for many undertakings, which upon reaching sufficient maturity came to stand on their own strength; the Weather Bureau, the National Bureau of Standards and the Bureau of Commercial Fisheries are all examples. The Smithsonian has no desire to see an organization of this nature centralized and inserted as a Bureau of the Institution. However, there is merit in considering that the Smithsonian (1) serves as the initial home of such an association on a temporary basis and (2) participate as a permanent and integral component through affiliation and partnership in a "consortium" approach. Through these means the Smithsonian Institution could contribute valuable and possibly otherwise unattainable assets.

Through its unusual character as a basically private Institution with strong governmental relationships, the Smithsonian can help provide the synthesis so critical to the successful creation of a national association of regional centers. Furthermore, the Smithsonian could help provide administrative support, including legel services, which will be so vital in the early stages of the association's development.

In our view, the basic concepts of an association of regional centers for ecological studies include: (1) a cybernetic system of research, education, and communication of information to society, (2) interdisciplinary and interinstitutional integration focused on contemporary ecological problems, (3) a network of regional university-based consortia, and (4) an ecosystem approach focused on man and his total environment. We would welcome the opportunity to join with Congress, the Ecological Society, private institutions, and universities across the land in meeting the challenges which confront this enterprise.

II. MANDATE FOR MISSION-ORIENTED ECOLOGICAL RESEARCH IN THE FEDERAL AGENCIES

The quality control of our environment is largely determined by the policies and activities of the various federal agencies whose concern is the management of the nation's natural resources. It is now clear that the exercise of this responsibility requires a strengthening of authority and financial support for the conduct of ecological research as a foundation for the management of these resources. A report prepared by the National Academy of Sciences for the National Park Service is illustrative of the problems involving ecological research that exist in one natural-resource agency of the Government. Is is submitted that the conclusions reached in the NAS report apply in general to the policies and programs of the Fish and Wildlife Service, the Bureau of Land Management, the Federal Water Pollution Control Administration, the Forest Service, the Soil Conservation Service, the Public Health Service, the Atomic Energy Commission, the Federal Power Commission, the Tennessee Valley Authority, and others.

It is acknowledged that there exists in statutory authorizations many directives for scientific research of various types of these agencies. Nowhere, is there a clear expression of the requirement for integration through an ecological approach in the research. These agencies should be granted explicit authority and sufficient funds to conduct ecological research and directed to coordinate existing research authorities into a mission-oriented ecological research program to provide, as applicable, the following items:

(1) An ecological survey and inventory of the lands and resources controlled or responsible for.

(2) An ecological analysis of problems in operational or regulatory management, administration, and planning resulting from, and contributing to, *inter alia*, program policy, visitor use, demographic, economic, social, and technological change as may relate to resource and landscape use and development.

(3) Cooperative planning with other Federal, State, and local agencies that administer or regulate the use of natural resources.

(4) The maintenance of selected areas under agency jurisdiction for representative, baseline ecological research, and

(5) Encouragement of research within the areas of jurisdiction by universities, private research institutions, and qualified independent investigators.

Furthermore, each mission-oriented, natural-resource agency of the Federal Government should be directed to establish a coordinator, or otherwise designated office: (1) to assist in the planning and coordination of research efforts within the department or agency and (2) to act as a point of contact for department or agency coordination with a Presidential advisory group and with the national association of regional centers for ecological studies described above.

III. A PRESIDENTIAL COUNCIL OF ADVISERS ON ENVIRONMENTAL QUALITY

The Smithsonian Institution believes that there is a need for a council in the Executive Office of the President to perform certain important roles for the President and the executive branch of the Government. Foremost among its functions, this council would: (1) advise and report regularly to the President on federal programs concerned with our environmental relationships and (2) assist in the formulation of national policy to preserve, protect, and improve the environment. Secondly, this council must: (1) act as a liaison between the various federal agencies that have responsibilities over certain aspects of the environment and (2) insure that the policies and programs set by the President are accomplished in an efficient and complementary fashion. As an alternative to the *de novo* establishment of this council, it could be developed as a specific function within the President's Office of Science and Technology.

If this Nation is to produce the kind of programs that are so widely recognized as necessary, neither the scientific community nor the public at large can afford selfish competition in finding a solution to the conditions which exist. This is the underlying position of the Smithsonian Institution and we look forward to working with your Subcommittee and all other concerned individuals and groups in achieving this goal.

In an effort to be constructive toward this end, may we suggest that your Subcommittee convene a conference at a suitable location near Washington to bring together a representative cross-section of outstanding individuals concerned with ecosystem science in an effort to narrow the range of alternative programs available and reach accord on a mutually satisfactory position. This would represent politics in its most progressive form and would be enthusiastically received, not only by those who participate, but by society at large. The Smithsonian Institution would be happy to assist in the administrative preparation for such a conference and would share some of the expense. It is further suggested that the Smithsonian facilities at Belmont, Maryland (descriptive brochure enclosed) might be suitable for such a conference. We would be happy to assist in developing a list of conferees that would incorporate the cross-sectional representation we think would be necessary.

SELECTED REFERENCES

Buechner, Helmut K. and *Fosberg, F. Raymond.* A contribution toward a world program in tropical biology. *BioScience* (August 1967), Vol. 17, No. 8 pp. 532–538. There is an urgent need to study the energy-rich tropical ecosystems, both to evolve new ecological theory and to provide the foundation of knowledge required for sound management of the tropics in man's best interest. This article is a report on a Conference on Tropical Biology held in Panama in November 1966.

Caldwell, Lynton K. Environment: A new focus for public policy. *Public Administration Review* (Sept. 1963), Vol. XXIII, No. 3, pp. 132–139. An inquiry into the need to view the total environment as a legitimate and necessary field of public action, and the consequent requirement for an integration of effort involving those social agencies that have a bearing upon the environment.

———. The human environment, a growing challenge to higher education. *Journal of Higher Education* (March 1966), Vol. XXXVII, No. 3 pp. 149–155. A discussion of some of the advantages that could be assumed to result from the use of an environmental focus in higher education.

Commoner, Barry. Science and Survival. 1966, the Viking Press. The simple necessities for human life—such as air, water, and food that are sufficiently uncontaminated to fall within man's physiological tolerance—are becoming increasingly difficult to provide because of environmental alterations created by the application of technology. Commoner cites examples of how man is fouling his nest through the unanticipated harmful effects of new technologies. He also endeavors to explain the social and political forces responsible for the contemporary situation. Erosion in the integrity of science under the pressure of social demands is a central issue in Commoner's argument.

———. Duty of science in the ecological crisis. *Scientist and Citizen.* (Oct. 1967), Vol. 9, No. 8, pp. 173–182. A brief account of the historical background and contemporary raison d'etre for the emerging alliance of scientist and citizen on environmental issues.

Ferry, Wilbur H. Must we rewrite the constitution to control technology? *Saturday Review* (March 2, 1968), pp. 50–54. Presents a thought-provoking argument for modifying some of our basic institutions to cope with the environmental consequences of sweeping technical change.

Ripley, S. Dillon. A perspective of the Smithsonian program in ecology. *National Parks Magazine.* (October 1966), Vol. 40, No. 229, pp. 10–13. This is the first published statement on the Smithsonian program in ecology.

———. The future of environmental improvement. *In* Enviromental Improvement, (air, water, and soil). pp. 85–93. Washington: The Graduate School, U.S. Department of Agriculture, 1966. The holistic concept of the ecosystem as an open-energy system, with human society as an integral component, is examined in this article, along with other fundamental ideas relevant in this emerging era of environmental awareness.

———. The challenge of adapting human societies to arid environments. International Center for Arid and Semi-Arid Land Studies, Publication No. 1, pp. 23–31. 1966. Against a perspective of man, fire, and grasslands evolving together, thoughts are focused on man's expansion of deserts through overgrazing; the ecological problems of irrigation; and progress of international educational and research programs.

Shepard, Paul. Whatever happened to human ecology? *BioScience* (December 1967), Vol. 17, No. 12, pp. 891–894. Illustrates the highly eclectric character of material that falls under the general heading of "human ecology" and provides a useful review of recent literature that has a bearing on the field.

Slobzodkin, Lawrence B. Aspects of the future of ecology. *BioScience* (January 1968) Vol. 18, No. 1, pp. 16–23. Ecology has a future, not only as an intellectual discipline, but also in terms of applying ecological thought to the practical business of mankind's survival. Problems of a social nature, of ecological engineering, and of environmental monitoring systems are cited to illustrate that their solution ultimately depends on knowledge from pure ecology.

STATEMENT OF MAURICE K. GODDARD, SECRETARY OF FORESTS AND WATERS, COMMONWEALTH OF PENNSYLVANIA

Mr. Chairman, Members of the Subcommittee, I am Maurice K. Goddard, Secretary of the Pennsylvania Department of Forests and Waters, and I welcome the opportunity to appear before you as you review the environmental pollution situation as it exists in this country today.

The Commonwealth of Pennsylvania, gentlemen, has more than its share of environmental pollution. It is a Commonwealth where our forefathers, far-removed and not-so-far-removed, feasted on a heavy banquet of natural resources and threw the bones under the table for posterity.

We probably cannot blame these empire builders for the destruction they wrought—they were riding the wave of industrial expansion and growth, and since the Commonwealth's supplies of coal, lumber, oil, and water seemed inexhaustible, they had few, if any thoughts of conservation and orderly development.

While their activities most certainly helped to make Pennsylvania the great industrial and mineral-producing State that she is, and contributed immeasurably to our national growth and economy, the simple fact of the matter, gentlemen, is that their past gluttony and lack of foresight have placed the Commonwealth in a position today of facing the future with a marred and disfigured face and an acute case of acid indigestion.

Being a forester by profession, I could more easily describe the devastation and destruction of Pennsylvania's forest areas by the lumber barons of the last century, and the long and painful period of recovery which is just now bringing our forests back into production. I am, however, going to limit my remarks to Pennsylvania's present mine drainage and mined land reclamation problems.

Both are massive, both are inhibiting our economic growth, and both will continue to do so in the future unless we meet them head-on today.

Judge for yourselves, gentlemen—the past six generations of Pennsylvanians have imposed about a 2 billion dollar burden on the present generation. Of this figure, slightly less than a billion dollars is the amount estimated that present and future generations will be saddled with for operation and maintenance of the projects and facilities necessary to do the job. This is what we estimate it will cost to rid our some 3,000 miles of adversely affected streams of mine drainage pollution.

These streams receive approximately 2,750 tons of acid per day from a mine water discharge of about 964,000,000 gallons. Roughly 75% of this flow emanates from abandoned deep mines.

On the reclamation side of the ledger, it has been estimated that over 300,000 acres of land have been disturbed by coal mining operations. This includes the huge accumulations of debris from deep mining operations, as well as the surface scars of strip mining operations.

When I first came to the Department of Forests and Waters as Secretary in 1955, everybody was discussing the effects of these problems on the State's economy with apprehension and dismay. The stock opinion was that they were too massive to be solved, and hence, we might as well accept them as necessary evils which would always be with us.

It is true that, back in the WPA days, some work was done on the sealing of abandoned mines. This program met with varying degrees of success, but was not followed up. It is also true that chemical reactions causing the formation of acid were understood at an early date, and hence, certain possible methods of abating acid pollution were known. In addition, it was evident that there was no single "cure-all", and that each individual situation would probably call for a different combination of techniques and methods.

In short, the fact that there was no single or simple solutions fostered the opinion that these inherited problems were, from both the economic and technical standpoint, too insurmountable to be tackled.

Now, gentlemen, I have never believed these criers-of-doom for an instant, and quite frankly, I got awfully sick of listening to them!

When I was a boy in New England and was faced with a problem for which I could see no ready solution, my grandpappy would invariably quote two common axioms—one of these was "Can't, never tried" and the other was "Where there's a will, there's a way!"

I won't say that his advice necessarily lessened my frustration at the moment, but I have never forgotten it, and I feel that it is just as true today as it was then.

Now, I would be quite remiss if I did not point out that great progress has been made in the Commonwealth since 1945 in the control and abatement of pollution from active mining operations and in the reclamation of surface areas affected thereby. For example, of the over 300,000 acres disturbed by coal mining operations, approximately 93,000 acres have been completely reclaimed and part of the remainder has been partially reclaimed.

Progressively since that date, through the process of passing new legislation and amending old laws, our General Assembly, prompted by the very evident desire and intent of Pennsylvania's citizens that stream pollution and surface disturbances caused by mining operations be controlled and eliminated, has given us the most effective legislative tools in the country with which to do the job.

For example, the 1965 amendments to our Clean Streams Law completely removed exemptions previously granted for certain mine drainage conditions and placed all mine drainage in the same category for regulation and control as industrial wastes. No mining will be permitted if discharges from mine areas will be, or will become, injurious to the public health, animal, or aquatic life; or prevent the use of waters for domestic, industrial consumption or recreational purposes.

Under the Clean Streams Law and other pertinent mining legislation, responsibility for administration, regulation, and enforcement are shared by the Sanitary Water Board of the Department of Health and the Pennsylvania Department of Mines and Mineral Industries.

I believe that I can safely say, gentlemen, that with effective implementation and administration of these laws, the adverse conditions stemming from active mining operations are now under control and will be eliminated. Our future generations may be assured that our mining activities of today will not compound our inherited environmental pollution problems.

As I stated earlier, however, the later are massive and must be corrected now, or Pennsylvania's economy will continue to suffer from their effect. In order to correct these conditions, we have four basic needs.

The first of these is money; the second is additional trained personnel; the third is additional research which I will qualify later; and the fourth is effective direction and coordination of effort.

Taking these needs in order the citizens of Pennsylvania recently passed a Contitutional Amendment authorizing the creation of a $500,000,000 Land and Water Conservation and Reclamation Fund, $200,000,000 of which is to be used by the Department of Mines and Mineral Industries to reclaim abandoned strip mine areas, eliminate abandoned deep mines as sources of acid mine drainage, and to mount an all-out attack on other problems arising from the mining of coal—subsidence, underground mine fires, as well as, the elimination of burning and non-burning culm piles.

I am happy to announce that, on January 19, 1968, Governor Shafer signed into law enabling legislation necessary to implement the Land and Water Conservation and Reclamation Fund. This action immediately released initial funds necessary to begin implementation of some of our planned projects and programs. Twenty "quick-start" projects, including 12 mine drainage treatment projects, 4 burning refuse bank projects, 3 underground mine fire projects and 1 major mine subsidence project were planned and were ready and waiting.

You will recall that I mentioned there is about a 2 billion dollar burden imposed on the present generation by the past six generations of Pennsylvanians. This figure is the estimated cost of implementing *Pennsylvania's 10-Year Mine Drainage Pollution Abatement Program for Abandoned Mines*. Obviously, the $200,000,000 available from the Land and Water Conservation and Reclamation Fund, while it will enable us to take a sizeable bite out of the program, certainly falls far short of what is needed to complete the work. Matching Federal dollars are urgently required to extend Pennsylvania's ability to complete this program, which is divided into four phases: (1) locating sources of pollution; (2) engineering studies and plans; (3) construction, which includes the least-cost combination of following techniques, sealing deep mines, burial of acid forming refuse, backfilling, diversion of water seeping into mines, regulation of streamflows, and treatment; and (4) operation and maintenance.

Incidently, substantial progress has already been made toward the completion of the first phase.

While we are on the subject of money, we strongly suggest that the Congress take a long, hard look at the relative size of the Federal Budget for our space effort in comparison to the amount of funds being provided for the correction of the environmental pollution problems which beset many sections of this country. We question, too, the relative size of the budget for research on various desalinization processes as compared to that for water pollution control.

While we recognize that there are beneficial spin-offs from these more glamorous programs, we respectfully submit that a better balance in Federal funding is urgently needed.

I cannot emphasize too strongly, gentlemen, that the correction of the environmental pollution problems associated with abandoned mines is not solely a Pennsylvania problem—they affect many other States. Because of the number of States affected, polluted streams are not respectors of State boundaries, and because the detrimental effects of these problems affect not only the State but also the National economy, these are National problems as well.

There are many people who will tell you that it is wrong to spend public moneys on correcting these problems—that an attempt should be made to locate the owners of the abandoned workings, or that the present coal industry should be saddled with correcting the sins of their long-gone brothers.

The simple fact of the matter is that, while we might agree that we would prefer that somebody else shoulder the burden, it is virtually impossible to trace these former owners and absolutely impossible to legally fix responsibility in those cases where the workings were abandoned prior to the passage of laws regulating mine drainage and requiring reclamation measures.

Of course, where it is possible to rectify the ills on past workings in conjunction with active mining operations, it is often possible to do so much cheaper with the cooperation of those in the private sector engaged in active mining.

I am not going to say too much about the need for additional trained personnel and technicians. This is a problem facing virtually every major program where technical skills and know-how are required, and failure to attract and utilize fresh technical blood could seriously delay our program.

Our hope is that the research programs which will be conducted by our colleges and universities will furnish additional specialists in this area. Most certainly, engineering personnel from allied fields, such as sanitary engineering, mine engineering, and hydraulic engineering, should lend their expertise to this work.

The third need—the need for research—is the one which I said I intended to qualify to some extent.

By this, I meant that our technicians in Pennsylvania are firmly convinced that many of the techniques and methods necessary to abate mine drainage and reclaim ravaged areas are already well-studied and well-understood.

Further, that research in these areas, except perhaps to find ways of reducing costs, is not urgently needed—we have adequate tools to begin and actually correct the problems now.

On the other hand, we do not deny that additional research is needed to find ways of lowering costs, to find ways of refining our cruder methods and to develop new approaches or techniques in certain areas.

I emphasize, however, that we do not need to delay our start for these.

The specialized areas where additional research is obviously needed would include: (1) research on the effects of auger-mining, (2) the study of the techniques of mining, and (3) the acid production which might be expected to result from application of these techniques and from different seams and associated formations.

Work in some of these research areas is already progressing and descriptions may be found in *Résumés of Mine Drainage Research Programs Sponsored by the Coal Research Board of the Department of Mines and Mineral Industries.* (Available in committee files.)

Further, there is an urgent need as research continues on some of the items contained therein for demonstration projects to determine the practicality of the methods that have been developed.

Also of interest is an excellent report on the *Status of Mine Drainage Technology by E. A. Zawadzki*, as presented by James F. Boyer of the Bituminous Coal Research, Inc., Monroeville, Pennsylvania, before the U.S. Committee on Public Works, Subcommittee on Air and Water Pollution, July 13, 1967. (Available in committee files.)

The fourth need—the need for effective direction and coordination of effort—is a real knotty one.

Here, we have quite a number of suggestions, and we feel constrained to point out that the role played by the Federal Government in these areas has been inadequate, too unwieldy, too slow, and their efforts have not only been too diversified, but have duplicated those already covered by the States.

The Federal agencies which have been involved thus far have felt that they must start from the beginning and, while this is probably a good way to train personnel, the past work of the States in the same areas has largely been ignored.

An excellent example of this was a number of demonstration projects initiated by the FWPCA which were never completed.

We suggest that, if it is necessary for the Federal Government to be actively involved in the abatement of mine drainage and in the reclamation of surface-mined areas in the individual States, then one Federal agency with manpower and facilities to collect, store, catalog, map, and abate mine drainage should be established at once.

Making one agency accountable for the program will prevent duplication of work and channel efforts of various cooperating groups in the proper direction. This would certainly be more economical and effective than the present duplication of effort.

Actually, the major effort in the abatement of mine drainage and reclamation—including research and pilot projects—has, to date, been made by the individual States.

The Federal Government programs have been hampered by poor coordination and duplication, particularly in studies and in misdirected efforts.

In Pennsylvania, the State agencies and the mining industry have contributed manpower, information, and pioneered research with little help from the Federal Government. Some of the programs have in reality been funded twice by the State through Federal funds and by State funds.

In fact, it is our feeling that large Federal administrative units are not needed to carry out these programs in the individual States.

Since the expertise already exists within the States—in the State agencies, in the State Universities, and the mining industry—we feel that we are far enough ahead so that, if an influx of Federal funds is directed to the State agencies, universities, and the private industrial research sector, these environmental pollution problems can be solved and corrected in the shortest period of time. We would hope, too, that these funds would be made available with a minimum of Federal agency restrictions and approvals with regard to the type of research to be carried out.

In your report to your parent committee, entitled *Environmental Pollution—A Challenge to Science and Technology*, 89th Congress, Second Session, Serial S, there is a statement on page 29 to which we must take strong exception. The statement that grieves us is the one that reads: "Mine drainage, whatever its effect on environmental quality, should not have funds spent on action programs until more palatable and sensible solutions can be devised."

You will recall that I indicated that our technicians in Pennsylvania are convinced that many of the techniques and methods necessary to abate drainage are already well-studied and understood, and that a combination of these techniques and methods can effectively solve the problems.

We grant that some of these techniques and methods, when applied, are quite expensive and that more research is needed to lower their costs or to develop cheaper alternative methods and techniques.

We do not, however, believe that we should delay action programs while waiting for such research to be carried out, or until "more palatable and sensible solutions" can be devised.

Even though the tools we have available at the present time may be expensive, we simply cannot afford to procrastinate any longer.

Our citizens are demanding immediate action and we are well aware of the fact that the Commonwealth's economic future is, in a large measure, dependent on completing the job as soon as possible.

As an example of exactly what I mean, let me tell you a little bit about what we are doing at our Moraine State Park in Butler County, Pennsylvania. This work is described in *Model Coal Mined Land Rehabilitation, Moraine State Park, Butler County, Pennsylvania.* (Available in committee files.)

Located in the Moraine State Park is the first strip mine reclamation project to be approved and carried out anywhere in the Appalachian Region under the Mining Area Restoration Section 205, of the Appalachian Regional Development Act of 1965, P.L. 89–16. The reclamation work at this park was approved in August of 1965 by the Appalachian Regional Commission, and actual work was begun on June 12, 1967. The entire project will cost about $219,000 for backfilling and revegetating 177.5 acres.

This particular park, which is currently under construction, is in an area badly disturbed by mining. The total acreage of the park is 15,999 acres and we expect to make it a "showcase" and demonstration area for coal mined land rehabilitation in the Commonwealth of Pennsylvania and in the Nation.

The cooperative efforts of the Pennsylvania Department of Forests and Waters and the Department of Mines and Mineral industries are being channeled into a number of projects in the area which will eliminate and control the harmful effects of past coal mining operations. These projects will restore the aesthetic appearance of the areas within the park disturbed by mining and insure that the 3,225-acre

Lake Arthur to be created in the park will not become a "dead sea" from mine drainage pollution.

It is our hope that this park with its $14,000,000 recreation area will become the Mecca for almost 2,000,000 visitors annually by the year 1975.

Some of the rehabilitation work is already well underway, but we have no illusions as to the magnitude of the job.

The environmental damage associated with deep and surface mining to be controlled and eliminated within the park area is: (1) acid drainage from underground and strip mines: (2) deep mine refuse piles and disfigured landscape riddled with over 100 mine openings; and (3) the stark and sterile spoil piles left in strip mined areas devoid of protective vegetation cover.

In short, gentlemen, we have in this area virtually every possible type of environmental damage.

The steps we intend to take to eliminate and control these harmful effects of past mining operations are: (1) the sealing and closure of deep mine openings to abate mine drainage; (2) the treatment of mine drainage which cannot be abated; (3) removal and burial of mine refuse piles; and (4) regarding and revegetation of strip mine spoil piles.

Also a recent *Summary and Status Report on Mine Land Rehabilitation Projects* being undertaken jointly by my own Department and the Department of Mines and Mineral Industries. (Available in committee files.)

This listing includes, in addition to another description of the work being carried out at the Moraine State Park, the status of other projects throughout the State.

You will find a short description of the Experimental Mine Drainage Treatment Plant which is being developed and which will be operated by the Pennsylvania State University for the Pennsylvania Coal Research Board of the Department of Mines and Mineral industries at Hollywood in Clearfield County, Pennsylvania. This facility will be used to obtain urgently needed engineering and economic data and will be capable of treating between ½ million to 1 million gallons of mine drainage per day, using the lime neutralization process. The design of the plant has already been completed and initial construction is underway. Completion of this vital effort is estimated to cost over $1,000,000 and is dependent upon receiving matching funds from the Federal Water Pollution Control Administration. These funds have been sought since December, 1966.

I would be remiss if I did not emphasize the magnificent work already done by researchers at The Pennsylvania State University. For example, a development by the University through State sponsored research in 1965 introduced a procedure to employ coal to treat polluted water at negligible costs which is being used by industry today.

Further, a summary of the complex nature of the mine drainage pollution problem and approaches to its solution has been presented by researchers at the University and was described to the Congress in 1967 by Representative John Saylor (Pa.). Reference is made thereto: Congressional Record—House, April 20, 1967, pages H-4410-19.

Recognition of the seriousness of the mine drainage pollution problem was emphasized at the University with the establishment of a Mine Drainage Research Section in January, 1968.

Another item in your subcommittee report which bothered us was an intimation that, where technology is not clearly available, enforcement agencies should not set up standards beyond the limits of that technology.

We respectfully submit that standards, goals, and objectives should not be limited by technology, but rather should be based on the public need and welfare. Further, if they are used as goals, they serve to keep the pressure on those concerned to improve technology and come up with new and effective answers.

Now, obviously, Pennsylvania's recent statutes have put the coal industry on notice, and I will be perfectly frank in saying that they are not only fighting for survival, but that they are doing an excellent job of it by stepping up their research and improving their technology to meet their specific mine drainage problems.

I believe that you will be interested in article included in Pennsylvania's Clean Streams brochure for the summer of 1967 which describes how the coal industry is moving on the treatment of mine drainage. (Available in committee files.)

While we are on the subject of industry, we suggest that, even with the excellent job the industry is now doing, their vast technical knowledge could be even more greatly utilized to the benefit of all concerned if a method of furnishing financial incentives could be devised.

In conclusion, gentlemen, I cannot emphasize too strongly that Pennsylvania is not waiting for a cure-all for her acid indigestion, or for a new and cheaper face-lifting technique for her disfigurement. Rather, we are proceeding with the techniques and methods we have now to assure our citizens of a better tomorrow.

It is significant that, in the Pennsylvania State Supplement to the Appalachian Water Resources Plan being prepared by the U.S. Army Corps of Engineers, we have recommended as an emergency and top-priority project, 6 mine drainage pollution abatement and land reclamation projects covering either major areas of the Commonwealth or in connection with other projects which would be worthless if these problems were not solved before their construction.

What we do, and what we learn, in Pennsylvania will obviously help our sister States in solving similar problems but frankly, gentlemen, we need help, both financial and technical, from every possible source.

The Commonwealth is moving, gentlemen, and we are dropping the gauntlet to the Federal Government to match our effort without delay.

STATEMENT BY WESLEY E. GILBERTSON, DIRECTOR, BUREAU OF ENVIRONMENTAL HEALTH, PENNSYLVANIA DEPARTMENT OF HEALTH

I wish to associate myself with the very excellent statement for your Committee prepared by a fellow Pennsylvanian, Dr. Maurice K. Goddard, Secretary of the Department of Forests and Waters.

As Director of Environmental Health for the Commonwealth's Department of Health, control of environmental pollution represents a major area of responsibility for me and the Bureau staff. For the purpose of the record, I would like to emphasize the actions being taken by Pennsylvania to prevent and control water pollution due to mine drainage. During the past year, we have processed and approved several hundred mine drainage applications for permits which include provisions for treatment by the operators of mines so as to neutralize acid and remove iron from the discharges. These permits, covering installations now in active operation throughout the State, range in capacity from a few hundred gallons to hundreds of thousands of gallons per day. Thus, with respect to discharges from active mines and those being proposed, we believe that we have technologies which are economically feasible.

Discharges from abondoned mines, however, still constitute a serious economic question. In order to tackle this massive pollution problem, the Department of Health has prepared a "Ten-Year Mine Drainage Pollution Abatement Program for Abandoned Mines." This program describes in general terms the extent and character of the problem and provides preliminary estimates of cost of abatement, utilizing available technology. A copy of this report is attached.* It should be noted, however, that this report was issued on March 1, 1967. Since that time additional information has been developed which indicates that the total cost of abating pollution from abandoned mines in Pennsylvania will approximate $1 billion. It is hoped that this information, together with that submitted by Dr. Goddard, will be useful to you in adjudging the availability of technology for pollution abatement with respect to pollutional discharges from mines.

I appeared before your Committee in the course of its previous hearings in 1966 and believe that your efforts in assessing research development and technology with respect to environmental pollution are of great benefit to the country. At the time of my previous appearance before you, I was in charge of the Department of HEW's new Solid Waste Program which had been underway only a few months before the hearings. Since that time I have become Director of Environmental Health in Pennsylvania. In my previous testimony I strongly emphasized the interrelationship between solid waste pollution problems and air and water pollution. I pointed out that satisfactory solutions to pollution control in any one phase of the environment must provide for adequate consideration for and protection of other phases of the environment. Our day-to-day experiences in Pennsylvania serve to strongly reinforce this conviction. Certainly there is a clear-cut need for adequate coordination and balancing of the respective functional areas and programs dealing with prevention and control of environmental pollution. Even more important may be the systematic analysis of future waste management requirements and comprehensive planning to meet over-all environmental objectives within economic feasibility. During the period ahead we will be attempting to apply this concept, not only on a statewide basis but with greater specificity in certain smaller geographical areas. Inherent in this process will be the use of improved systems analysis methodology. Much is being said about this field, but the actual application of this approach will require considerable experimentation.

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*The report referred to may be found in the Committee files.

As Chairman of the Committee on Environment (membership list attached) of the American Public Health Association, I wish to emphasize the views of the Committee as expressed recently on the subject of priorities for Federal Research and Development funds. Considering the substantial and growing problems in the field of environmental health and environmental pollution control, including those which are particularly serious in the more congested urban centers, the Committee feels that in the future a higher priority for Federal R & D funds should be accorded this area. The Committee is well aware of the implications of the R & D efforts relating to the space program and defense but feels that the future needs for achieving a livable environment will necessitate a larger share of available Federal R & D funds. In this connection it would be desirable to establish clear-cut sets of environmental objectives, with time tables, so that both mission-oriented and nonmission-oriented R & D projects might be assessed in terms of their contributions toward the accepted objectives.

For the information of your Committee I might comment on the extent of application of new air pollution control processes relating to sulfur which are now undergoing evaluation in Pennsylvania:

(1) A pilot plant was installed in 1967 and is now operating at Pennsylvania Electric Company's Seward Power Station to make use of the coal cleaning operation as a method for obtaining sulfur removal. The objective of this process, which appears attainable, is to remove from 60 to 70% of the total sulfur in coal during the pulverization and cleaning process and before combustion.

(2) A prototype plant began operation in August 1967 at the Portland generating station of Metropolitan Edison Company which may be characterized as a "catalytic conversion" process. This process has the objective of removing the following from the fluegas: 99.5% of particulate matter; 90% of SO_2; and 99.5% of sulfuric acid. The plant produces sulfuric acid as a byproduct.

COMMITTEE ON ENVIRONMENT

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STATEMENT OF DAVID M. GATES, DIRECTOR, MISSOURI BOTANICAL GARDEN, ST. LOUIS, MO.

Ecology is a very complex, difficult basic science. It is a holistic science that incorporates all other branches of science and for this very reason is less specific and more diverse. Ecology is the very epitomy of science itself. The ecology of terrestrial natural history involves an understanding of man and of the biota and environment of the planet Earth. Ecologists have been very few in number, the science of ecology is relatively new, and basically it has only begun to flourish as a brilliant intellectual discipline. The potential for ecological thought and ideas is enormous.

The vast number of applications for ecology to the welfare of man is both a challenge and a threat. Every single activity of man perturbs an ecosystem that was different prior to the hand of man. Man exploits and uses the energy and resources of ecosystems and finally wishes desperately to understand and manage the ecosystem through rationale. Man replaces complex, stable ecosystems with monocultures which are subject to a potential instability. The demands on the ecologist for advice with respect to the management of ecosystems is enormous and yet it is the complexity of the problems which makes it so apparent that ecologists are too few with too little information and method.

Never in the history of mankind have ecologists received the support and inducement comparable with the complexity and diversity of their subject matter. Ecologists, for reasons often beyond their control, have been able to only dabble in the science of ecology. By virtue of constraints within the educational system, by traditions, and by other limitations (some fiscal), the ecologists have been unable to cope with the enormity of ecological problems. This statement can be spelled out explicitly in terms of methodology, equipment, data handling, and basic analytical technique. Ecology requires a strong theoretical structure which is built on an erudite understanding of biological systems, a deep understanding of individual organisms, a grasp of molecular and evolutionary principles, and a thorough application of mathematical techniques. Few, if any, ecologists have ever received such training. It is crystal clear that modern science is absolutely capable of producing ecologists of this calibre.

The ecologist can advise well and demonstrably concerning a wise course of action with regard to many of man's pressing environmental problems. Yet the ability of the ecologist to give the "best" advice is often limited by the complexity of the problem. Two types of individuals are desperately needed for the immediate future: the ecologist who is trained as a basic scientist with as much of the knowledge of science (physics, chemistry, mathematics, biology, and sociology) as possible, who will work on the fundamentals of ecology; and the environmental engineer who is trained as the applied scientist to direct his effort towards the management of environmental problems confronted by man. This is not to say the ecologist, trained and interested in the fundamentals of the science, will not take an interest in the environmental problems of man. Indeed, he will. It does not say the environmental engineer will not learn something of the fundamentals of ecology. Indeed, he should and will. It merely emphasizes that the science of ecology and the problems of environment are so complex that it is entirely unreasonable to expect too few to do much with too little. We have run out of time and as a nation of great technology and scientific achievement we can and must correct the situation. To expect the professional ecologist to have done otherwise in the past or to expect a solution to come without a strong impetus and directive from national policy is unreasonable. The following recommendations are made as some of the possible means to correct the situation and the trends.

1. Vigorous support of basic training and of research programs in ecology. One to three ecologists per major university are far too few. Ten to twenty ecologists might be reasonable per university.
2. Emphasis on theoretical ecology as a challenging intellectual discipline which will attract theoretical physicists and chemists and applied mathematicians to the fold; but it is axiomatic that they must understand biology just as the astrophysicist is trained in physics and understands astronomy.
3. Establishment and support of ecological research centers which emphasize an understanding of specific ecosystems.
4. Training of applied ecologists to be known as environmental engineers with the same kind of relationship to ecology that engineers have to physics.
5. Recording and understanding the natural history of the planet Earth before it is too late. Complete documentation of all ecosystems must be done. This cannot wait for another generation or two or we will never know what the relatively undisturbed biota of many parts of the world were like. It is nearly too late now to understand many regions in their undisturbed state. It is also important to continue to record and understand various ecosystems throughout all stages of disturbance and change.
6. Preservation of the plants and animals of the world in the large systematics collections of the museums and herbaria. These great natural history collections contain the voucher specimens of the diverse flora and fauna of the world as evolution brought them into the twentieth century. It is primarily by use of the systematics collections that the biologist can understand the threads of evolution. Systematics collections are the bench marks of natural history and indeed the cornerstones of biology. The great systematics collections must be treated as one of our most precious commodities, yet they have been seriously abused and disregarded. They must be supported well.
7. Preservation against all encroachment of certain natural areas for future study and collecting. These areas should include representation of basic ecosystems such as rivers, lakes, ponds, forests, sand dunes, estuaries, prairies, tundras, etc. It should be self evident that we should not be the last generation to have available for study relatively undisturbed ecosystems. Future generations should have the

opportunity to learn natural history as well as to learn the lessons of history.

8. Preservation of gene pools of living plants and animals within botanical gardens and zoological parks. These gardens and parks are important repositories of living organisms, not only for the public to see and enjoy, but for students and scholars to study and to understand.

STANFORD UNIVERSITY SCHOOL OF MEDICINE,
STANFORD MEDICAL CENTER,
Palo Alto, Calif., March 4, 1968.

Hon. GEORGE P. MILLER,
House of Representatives,
Washington, D.C.

DEAR MR. MILLER: H.R. 7796 by Representative John D. Dingell has come to my attention. I strongly favor any actions by the Federal Government that will contribute to a heightened level of concern and involvement on the part of this nation in addressing itself to problems associated with the impact of the population explosion and the technological revolution on the environment of the earth.

It is my persoal belief that there should be a key involvement on the part of the nation's educational institutions, and that within the colleges and universities this involvement should have a strong interdisciplinary character.

I have suggested to Representative Dingell that the words "educational institutions" be inserted somewhere in lines 1 or 2, on page 2 of H.R. 7796. He has responded that it is his "intention that educational institutions play a major role * * *." He has suggested that I make my views known to you.

I retain my belief that explicit reference should be made to "educational institutions" in the bill, perhaps not only in the vicinity of line 1 or 2 on page 2, but also around line 22 on page 4. I believe, as a scientist (physicist) that the resolution of the environmental problems before us will call for a broad application of talent. Within the universities I believe that, whereas the contribution of science and engineering will be crucial, the resolution of issues relating to the quality of life must draw upon the talents of all individuals with social concern who care to become involved. The words "educational institutions" it seems to me would cover it.

With great respect for the efforts of Representative Dingell,

Sincerely,

SIDNEY LIEBES, Jr.

CORNELL UNIVERSITY,
DIVISION OF BIOLOGICAL SCIENCES,
Ithaca, N.Y., April 1, 1968.

Mr. RICHARD A. CARPENTER,
Senior Specialist, Science Policy Research Division, Legislative Reference Service, Library of Congress, Washington, D.C.

DEAR MR. CARPENTER: In reply to your letter of March 20, I shall try to answer your questions.

1. I enclose a xerox copy of a question and answer giving the figure 130 curies per day. This is from the magazine "Scientist and Citizen" published by the Committee for Environmental Information, 5144 Delmar Boulevard, St. Louis, Missouri 63108. The Committee includes a number of prominent scientists and has a National Science Advisory Board of which I am proud to be a member. We try very carefully to screen out anything that might be successfully challenged, and nobody has challenged that statement.

Furthermore, calculations from independent data lead to the same figure for a boiling water reactor of that size. Also from independent sources we can estimate that the radioactivity put into the atmosphere would consist of about 20 curies of tritium with most of the remainder being ^{85}Krypton. I'm sure you know that, although the modern definition of a curie is 37 billion disintegrations per second, this corresponds closely to the activity of a gram of radium. In terms of biological hazard, of course, radium is the most dangerous with tritium being much more dangerous than Krypton.

I sent back the transcript of the hearing and can't recall just what was said about England discharging high-level radioactive wastes to the sea. As I recall, Chairman Miller asked if that were not the case and I replied that I had heard such a report. A cursory search of my files shows that a 1958 statement from the British Windscale reactor reports that they were releasing into the Irish Sea "several hundred millicuries of alpha-emitters a day." This is extremely vague but one can guess that it refers to ^{90}Strontium which is indeed a "high-level radioactive waste." Also, presumably, this antedates the accident at Windscale which released to the atmosphere large quantities of ^{131}Iodine—perhaps the potentially most dangerous reactor accident that has occurred to date (although the accident in the Fermi reactor, 30 miles from Detroit, on October 5, 1966 is said to have released "some radioactivity" to the atmosphere—I have been unable to learn how much of what was released). I really don't know anything about England's disposal of radioactive wastes; it's difficult enough to learn anything about what's happening in this country.

2. I stated that I was not overly happy with my calculations of the oxygen balance in the atmosphere but I'll outline my procedure since you asked. If you want to pursue it further I'll be happy to send the detailed equations of the combustion formulas assumed.

(a) After months of careful study of all available data I published an estimate in Scientific American (April, 1958) that the net annual production of plant material for the earth amounts to 5 x 10^{17} kilocalories. This corresponds to the annual release of 1.43 x 10^{17} grams of oxygen. Since then a number of leading students of the subject have told me that they are convinced this is the correct figure, so I'm quite satisfied with this.

(b) The surface area of the earth is 510, 101 x 10^3 KM^2. Thus the 1.43 x 10^{17} grams of oxygen is produced on 5.1 x 10^8 KM^2 or an average of 2.8 x 10^8 grams per square kilometer.

(c) The area of the 48 coterminous United States is 9,363,389 KM^2. This includes our deserts, cities, mountains, etc. It is more productive of plant life than many parts of the world but much less productive than tropical forests or large areas of the sea. If we assume it to be average for the world it would annually produce 2.62 x 10^{15} grams of oxygen.

(d) The 1966 U.S. petroleum production corrected for imports and exports amounted to 3,628,366,000 barrels of 42 gallons each. We assume a specific gravity of 0.9. This amounts to 5.19 x 10^{14} grams. Following a petroleum chemist, I take its average composition to correspond to the empirical formula C_7H_{12} (this assumption can be varied widely without noticeably affecting the result). I assume it to be completely oxidized to carbon dioxide and water (this is fair enough because the unburned hydrocarbons spilled and emitted to the atmosphere are eventually oxidized). This oxidation would consume 1.73 x 10^{15} grams of oxygen.

(e) I (arbitrarily) lump coal and peat together and find for the 1966 U.S. production, corrected for exports, 4.24 x 10^8 tons or 3.85 x 10^{14} grams. Assuming 10 percent to be non-combustible and to remain as ash, this gives 3.46 x 10^{14} grams oxidized annually. Let's assume its composition to be CH (again, the conclusion is insensitive to wide variations in this assumption). This would consume about 1.08 x 10^{15} grams of oxygen.

(f) For natural gas our 1966 production was 17,116,826 million cubic feet or 3.66 x 10^{14} grams. We can with negligible error take this to be entirely methane (CH_4). Its complete combustion would consume 1.46 x 10^{15} grams of oxygen.

(g) For the natural gas liquids our 1966 production was 19,682,722 thousand gallons or 3.66 x 10^{14} grams. Taking the average composition as C_4H_{10} (again insensitive to variations), its combustion would consume 1.73 x 10^{14} grams of oxygen.

If we add together these four figures for oxygen consumed we get 4.46 x 10^{15} grams per year which is 170% of the 2.62 x 10^{15} grams produced by photosynthesis, indicating that we are vitally dependent on oxygen brought in from outside the coterminous United States by atmospheric circulation.

You asked about the land area of the U.S. occupied by urban society. According to the 1967 H.E.W. Task Force report (A Strategy for a Liveable Environment—"the Linton report" p. 18): "Today, there are 140,000,000 people living on 35,000 square miles of land." This is just about 1% of the total area of the coterminous states including bodies of water.

The figure I presented of one million acres per year being removed from photosynthetic productivity is a commonly used figure which is undoubtedly conservative. It corresponds to a square of slightly under 40 x 40 miles. It is half the area under concrete in the National Interstate Highway System. It doubtless greatly underestimates the amount of land lost annually to dumps, parking lots, shopping plazas, and mine pits and tailings—not to mention over 1.25 million new housing units started in 1966 and the areas put out of production by pollution.

I hope this information will be of use to you.

Very sincerely yours,

LAMONT C. COLE,
Professor of Ecology.

NUCLEAR POWER: IS IT SAFE?

DEWITT, N.Y.

DEAR EDITOR: How can we be sure that the power reactor being built in our area satisfies reasonable safety requirements, (accidents, waste, etc.)? We would like (a) a general answer, for any part of the U.S., (b) specifically, for the Niagara Mohawk Power Co. of N.Y.

MR. and MRS. F. R. ROHRLICH.

The power reactor in question is the Nine Mile Point Nuclear Station under construction by the Niagara Mohawk Power Company on the shore of Lake Ontario, about seven miles northeast of Oswego, New York. When completed, this would be the largest nuclear reactor ever built for civilian electric power, although other still larger reactors are being planned for other sites. It will produce about 525 million watts of electrical energy; the fuel will consist of about 100 tons of uranium.

In such a reactor, small amounts of radioactivity will be released into the water of Lake Ontario, and into the air from the reactor's smokestack. Although the amounts of radioactivity are small, there remains a definite risk, for any amount of radioactivity does some damage to living things. Niagara Mohawk estimates that the maximum amount of radioactivity released from the smokestack during normal operation will be about 130 curies per day (a curie is the amount of radioactivity of one gram of radium). About one-fiftieth of a curie will be released each day to the waters of Lake Ontario. These levels are well below the standards established by the Atomic Energy Commission, but the question of their safety is actually more difficult to resolve.

In the absence of adequate information on the effects of radiation, it is difficult to set safety levels. As in the problems of fallout, there are also complicating questions created by the fact that levels of radioactivity that are low to start with may be concentrated by plants and animals, eventually appearing in human food at higher doses than would be otherwise expected. Little information on the movement of radioactive substances through the living environment has been available, and as a result, the setting of safety standards for radioactive emissions has been necessarily somewhat arbitrary.

More recently, additional information on the levels of radioactivity in areas surrounding nuclear reactors has become available, which should make possible at least the beginnings of an effort to evaluate AEC standards against the risk which is actually present. A coming issue of *Scientist and Citizen* will summarize our current knowledge in this area.

The possibility of a serious accident must also be considered. Should even a small proportion of the radioactive fuel of a reactor be released to the atmosphere, the results would be catastrophic. Such an event could occur if the rate at which fission is proceeding in the fuel elements were to increase beyond the safety level. This would result in enormous overheating of the reactor core, followed by melting or cracking of the structures which contain the uranium. A cloud of highly radioactive gases would be released which would then move with the wind, doing enormous damage until it dispersed.

The Atomic Energy Commission bears the responsibilities for seeing that both normal operating hazards and the risk of a major accident are kept to a minimum. This is done by locating reactors in relatively unpopulated areas, and by seeing that they are designed to minimize risk. The Nine Mile Point Station is situated only seven miles from Oswego, a town of about 23,000, so that design considerations are paramount, for should any major release of radioactivity to the air occur, the city of Oswego would be seriously endangered.

Because of the time and expense involved in building a nuclear power reactor, construction is usually begun before the design of the reactor is complete. A power company which wishes to build a reactor applies to the AEC for a construction permit, submitting preliminary plans. The AEC then prepares its own analysis of the proposal, and a public hearing before a specially constituted Licensing Board is held.

In the case of Niagara Mohawk, such a hearing was scheduled for December 15, 1964. Instead, however, a private conference among the applicant, the licensing board and other interested parties was held on this date, and the public hearing was postponed until January 15. Following the hearing, the findings and conclusions of the licensing board were made public, and a construction permit was granted. The findings and conclusions of the Licensing Board were written by the applicant, Niagara Mohawk Co., and were accepted with only minor changes by the AEC.

At some future date, Niagara Mohawk will submit final design plans for the reactor, and the AEC will decide whether or not to grant an operating permit.

In the near future, S/C will publish an analysis of normal operating hazards from nuclear reactors. In our April, 1964, issue we discussed in detail the accident hazard from the then proposed Bodega (California) reactor, which has since been abandoned. We plan a more general treatment of this problem, with special attention to reactors which are projected for the near future, such as Niagara Mohawk's Nine Mile Point Station.

CONSOLIDATED EDISON CO. OF NEW YORK,
New York, N.Y., April 16, 1968.

Hon. EMILIO Q. DADDARIO,
Chairman, Subcommittee on Science Research and Development,
House of Representatives, Rayburn House Office Building,
Washington, D.C.

DEAR MR. DADDARIO: Your letter of March 8th asked that we provide your subcommittee with certain data relative to the economics of air pollution control. The information requested is submitted herewith in the hope that it will be useful in your studies. If you have questions or need additional data, please do not hesitate to so advise us.

Inasmuch as equipment to remove sulfur oxides from flue gas has not been sufficiently developed to permit its use on large generating units, we have been utilizing low sulfur fuels to reduce sulfur oxide emissions. During the past fuel year (April 1, 1967–March 31, 1968) we have been converting to coal and oil with a sulfur content of 1%, which compares with a permissible sulfur content of 2.2% under the New York City Air Pollution Control Code. Prior to this change, our coal cost approximated 33¢/MM Btu; it is now more than 37¢/MM Btu. Our residual oil formerly cost 33¢/MM Btu; with a 1% sulfur content, it also has now increased to more than 37¢/MM Btu. Based on estimated generation for the year 1968, these increases will add about $15,000,000 to the electric system fuel bill and about $2,000,000 to our central steam system fuel costs. Our electric and steam rates include an adjustment for changes in the cost of fuel whereby customers' bills reflect such modifications.

We estimate that the annual bill of our average residential customer will be increased about 1.5% in 1968 because of utilization of 1% sulfur fuel. For an average space heating customer the increase will be approximately 2.5%.

The Company has been investigating possible sources and prices for oil with less than 1% sulfur content. However, the cost of such oil is not well enough established to draw conclusions at this time.

It should also be noted that, over the years, Consolidated Edison has made capital expenditures of approximately $126,000,000 on various phases of air pollution control. Within another year this total will amount to about $150,000,000, of which approximately $3,500,000 will have been spent to accommodate the low sulfur oil. Although the customers' bills must eventually reflect the costs of supplying service, it is not possible to pin-point readily the effect of such capital expenditures on individual rates.

Very truly yours,

W. DONHAM CRAWFORD.

APPENDIX C

Letters Concerning H.R. 13211

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THE ROCKEFELLER UNIVERSITY,
New York, N.Y., November 3, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Washington, D.C.

DEAR SIR: This is to acknowledge receipt of your letter of October 25 concerning HR 13211, the "Ecological Advisors Act of 1967."

I have read the bill and the speech you made on the floor of the House on September 27, 1967. In my opinion, your statement of the problem is one of the best, if not the best, that I have ever read. I was particularly gratified to notice your concern with the fact that we deal with environmental problems in an ad hoc episodic manner, whereas it is certain that we shall not be able to solve the problems that are before us unless we take much longer range views of the ecological situation. I hope that the Council of Ecological Advisors might contribute to the formulation of an integrated approach to environmental problems.

Yours sincerely,

RENÉ DUBOS.

EASTMAN KODAK CO.,
Rochester N.Y., November 6, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Congress of the United States,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: Although it has been my privilege to give testimony on a number of occasions on proposed legislation, I cannot remember a single instance when, even though I favored the proposed bill, I did not have at least minor modifications to suggest. Consequently it is a real pleasure to tell you that I am enthusiastic about H.R. 13211, and would strongly urge its enactment, as one of the most important and constructive actions which the Congress and the President can take.

The proposed action in establishing a Council of Ecological Advisers parallels the recommendation of the Linton report, "A Strategy For a Living Environment," and I believe is sufficiently urgent to move ahead of other legislation which is likely to come from that report. The placement of such a Council at the level proposed is essential to give it the importance and visibility needed for the vital job assigned to it. I served on the National Advisory Committee for Environmental Health to the Public Health Service (and am a member of its sequel, the National Advisory Council on Disease Prevention and Environmental Control) at the time responsibilities for water pollution were transferred to the Department of the Interior, and while understanding the influences involved, was dismayed at the further fragmenting of responsibilities in the attack on our total environmental health problem. Similarly, I have followed closely the "mix" with respect to ionizing radiation between the Atomic Energy Commission and the Division of Radiological Health (now the National Center for Radiological Health) in the separation of "occupational" from "public" responsibilities.

It was my privilege to serve as a member of an ad hoc Office of Science and Technology Committee to stimulate, in the 1950's, a much more realistic attack—and organization—by the Public Health Service in environmental health activities. From those meetings, the Gross Report was engendered—with such results as an escalating effort in air pollution—with a budget of four million in 1960 to sixty-four million in 1967.

That the effort should not and cannot be relegated solely to the federal government seems most important to me. In the 1950's when I was a member (and later Chairman) of the Council on Occupational Health of the American Medical Association, I repeatedly urged the Board of Trustees to mount a major activity in environmental health—and when a Council on Environmental and Public Health was established in 1963, I was asked to chair it, and have continued in that capacity. We have conducted four annual and major Congresses on Environmental Health, and plan for our Fifth Congress next spring, a constructive and critical evaluation of the Linton Report, and an exploration as to how we can get greater and more meaningful involvement of the medical profession. Too, the Council in a joint partnership with the National Center for Air Pollution Control, has held one Conference, and will conduct another Conference on the Medical Effects of Air Pollution in Denver next July. Our first meeting, last year in Los Angeles, attracted some 500 experts from many foreign countries as well as the leaders in the United States and Canada.

There has been a most gratifying response from industry in the control of environmental health hazards, once the story was effectively presented. I serve as Chairman of the Environmental Health Advisory Committee to the Manufacturing Chemists' Association. Within that organization alone, thousands of industry people have received training, through many workshops conducted on water pollution and air pollution control and occupational health. A substantial research program has been developed, and individual industries have been stimulated to action. There's much yet to be accomplished, of course, but there is substantial acceleration.

The need for support from an enlightened and motivated citizenry in the attack on air pollution has been noted frequently. Many of the "citizen groups for clean air" in communities lacked a support base and an organized and sustained effort. I chaired a subcommittee for the National Tuberculosis Association to consider this matter, and from our recommendation has evolved the National Air Conservation Commission, with such eminent members as John Charles Daly, Barry Commoner (Director, Center for the Biology of Natural Systems, Washington University), Leslie A. Chambers (Director, Allen Hancock Foundation, University of Southern California), John Logan (President, Universal Oil Products Company), Athelston Spilhaus (President, Franklin Institute), George R. Taylor (Economist and Secretary, Staff Subcommittee on Atomic Energy and Natural Resources, American Federation of Labor-Congress of Industrial Organization), and others. The Commission is developing a program through which the 1500 affiliate Tuberculosis and Respiratory Disease organizations across the nation will serve as foci for community organization and action against air pollution. In December we are convening representatives from thirty or more of the "big city" associations to emphasize action immediately at that level. It is my privilege to serve as Chairman of the National Air Conservation Commission.

Last week I presented a proposal at the Annual Meeting of the American College of Preventive Medicine for the establishment of a National Council on Hazardous Physical and Chemical Agents. This organization, patterned after the National Council on Radiation Protection and Measurements, would serve as the scientific and professional body for developing *criteria* for agents other than ionizing radiation. The National Council on Radiation Protection and Measurements, chartered by Congress, is composed of eminent scientists and professionals, nominated only by professional and scientific organizations. Industry, government, labor, and universities are not represented as such, but the National Council on Radiation Protection and Measurements contains a well balanced composition from all those groups. When the Federal Radiation Council was established by

Presidential order, it was admonished to consult with the National Council on Radiation Protection and Measurements on scientific matters.

Such a body would establish *criteria*—with the responsibility of government to establish *standards*—accepting or rejecting the proposed criteria as a basis. We might avoid such crises as occurred recently with the Public Health Service Sulfur Dioxide Criteria. Had these criteria been developed by an eminent and independent scientific body, they would have had a much higher degree of sanction and acceptance. With such a council providing the scientific interpretation, a Council of Ecological Advisers would be helped in integrating the other factors, social, economic, political into the kinds of recommendations our society needs and must have.

I am sure that when you sent me your letter you didn't expect such a fulsome reply. This background, however, may give some added weight to my enthusiastic endorsement, and my encouragement to press forward with your proposed legislation. In fact, I feel so deeply about the urgency of these problems that I'm changing my base of action, by taking an early retirement from Kodak (next February 1) and becoming Professor and Chairman of the Department of Environmental Health in a new School of Public Health in Houston, Texas. The new school will be a part of the University of Texas system and will be located in the Medical Center in Houston.

I shall be pleased to do anything I can to advance the proposal which you have made. I'm enclosing two examples of my "missionary" efforts to create an awareness of the serious job ahead.

Sincerely,

JAMES H. STERNER, M.D.,
Medical Director.

UNIVERSITY OF SOUTHERN CALIFORNIA,
ALLAN HANCOCK FOUNDATION,
Los Angeles, Calif., November 9, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives, Longworth House Office Building,
Washington, D.C.

DEAR MR. TUNNEY: You are most correct in your assumption that concern for environmental quality has brought me into contact with several federal agencies and offices. In each there has been found sympathetic understanding of the need for a total ecological systems approach to management alternatives, but in none has there resided sufficiently comprehensive legislative authority to encompass the whole interlocking network.

In spite of this deficiency in existing governmental machinery this University, and a handful of others throughout the country, are in process of structuring interdisciplinary programs of graduate education and research designed to develop a "technology of complexity" related to the urban environment, and to produce a new breed of environmental managers. You can imagine the difficulties involved in activation of a horizontal administrative structure against the traditional vertical disciplinary grain. At USC the new program is called the Institute of Urban Ecology. It is proceeding with about 15 graduate students from a variety of professional and academic schools, under the combined and enthusiastic tutelage of a strong volunteer faculty representing systems analysis, demography, social sciences, engineering, medicine, public administration, the law, architecture, planning, the natural sciences and other areas. Progress has been slow thus far, primarily because funding must be secured in the form of multiple grants each of which must conform to the categorical mandates of the respective granting agencies. It is most difficult to sustain a central coordinating professional staff under such circumstances. However, the need for the Institute's potential products is so evident that we must find ways of accomplishing our objectives.

For this reason, among others, your bill (H.R. 13211) and your related remarks are most welcome. By some means the government must contrive analyses of ecological systems involving man, and assure a capability for generating logical sets of optimal choices available to urban managerial decision makers. The Council of Ecological Advisers you propose, if sufficiently comprehensive in breadth of competencies represented, and if constituted to avoid undue restraint by members committed to specific categorical programs, would provide the Executive and the Congress with objective recommendations which could result in effective coordination, or the creation of alternative federal mechanisms.

Senator Muskie, some months ago, sent me a copy of a bill in which he proposed that a council be set up within the Senate, comprised of selected members from each of the relatable Senate Committees, to consider for two or three years the total environmental quality control needs and make legislative recommendations. I have no information as to the fate of his proposal; probably it has come to your attention.

The urgency of the need for ecological analysis of our urban systems seems to be recognized by almost all responsible and thoughtful people; the means of doing it in the face of a proliferation of governmental agencies fundamentally geared to cope with bits and pieces of the complex network, is certainly not obvious. Those of us seriously concerned with the problem are delighted to learn of your interest and efforts.

Perhaps it would be possible for you to visit the U.S.C. campus when you are back in California, to discuss with our very dedicated group both your proposal and our plans. In fact, we would be most pleased to have you associated with the Institute of Urban Ecology as a member of the Advisory Council. Senator George Murphy has accepted such an appointment. The Council provides one of the mechanisms through which the Institute relates directly with local, state and national governmental and legislative processes.

Thank you for acquainting me with your proposal and be assured of our support in any well considered actions related to environmental management.

Sincerely yours,

LESLIE A. CHAMBERS,
Director, Allan Hancock Foundation.

ATON FOREST ECOSYSTEM RESEARCH STATION,
Norfolk, Conn., November 11, 1967.

Hon. JOHN V. TUNNEY, M.C.
House Office Building, Washington, D.C.

DEAR MR. TUNNEY: Thank you for your letter of November 7th, with a copy of your Bill, and your statement in the Congressional Record on p. H 12604 et seq.

I whole-heartedly and unqualifiedly endorse your Proposal, and your approach as exemplified in your statement on the Floor of the House.

You will find strong support for this Council, I believe, in Dr. Dillon Ripley, Secretary of the Smithsonian Institution, and Dr. Helmut K. Buechner, Head, Office of Ecology of the Smithsonian. Several of their speeches in the last few years point out the need for a new and greatly enlarged view toward "ecology", which itself had had too many *specialist* devotees.

I shall follow the progress of your Bill with great interest.

Sincerely,

FRANK E. EGLER.

NATIONAL TUBERCULOSIS ASSOCIATION,
New York, N.Y., November 13, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Congress of the United States,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: We appreciate your inviting our comments on your proposed bill, H.R. 13211.

I believe that any organization concerned with pollution of the environment is aware that the solution to the problem is too huge to justify continued fragmentation of efforts. It seems to us that the time is ripe for the type of national council of advisers your bill proposes.

Dr. James Sterner, Chairman of the National Air Conservation Commission which was created by our organization, has sent us a copy of his letter to you in which he personally endorses H.R. 13211. Dr. Sterner's many years of experience with scientific groups which have been working on this problem speaks for his qualifications to comment on the subject and we are glad to be able to add our approval to his.

Sincerely yours,

JAMES E. PERKINS, M.D.,
Managing Director.

University of Illinois,
Center for Human Ecology,
Urbana, Ill., November 16, 1967.

Congressman John V. Tunney,
Congress of the United States,
House of Representatives,
Washington, D.C.

Dear Congressman Tunney: I have your letter of November 3 in which you request that I comment on H.R. 13211. I brought your letter and its attachments to the attention of the members of the Committee on Human Ecology of the Ecological Society of America at its meeting of November 13–14.

We decided that "Ecological Advisors Act of 1967" was sufficiently important to demand a supporting statement from the Committee as a whole. We shall prepare this statement, obtain the necessary approval of the Executive Committee of the Ecological Society of America, and then transmit it to you for whatever use you may deem appropriate.

If you should also find it useful to have separate opinions from the individual members of this Committee, each has agreed to respond to a request from you. The names and addresses of these men are attached.

Yours sincerely,

Frederick Sargent, II, M.D.,
Chairman, Committee on Human Ecology, ESA,
(*Director, Center for Human Ecology*).

UNIVERSITY OF CALIFORNIA,
Berkeley, Calif., November 20, 1967.

Hon. JOHN V. TUNNEY,
Longworth House Office Building,
Washington, D.C.

DEAR MR. TUNNEY: I appreciate the opportunity of reading your proposed "Ecological Advisors Act" and your speech explaining the purpose of the act.

Pollution of the environment, air, land and water, is of the greatest importance. It poses a threat to the health and even the life of all living things, including man.

The threat of radioactivity is so dramatic that it is carefully monitored. The dangers from pesticides, herbicides, toxic fumes, detergents and many other products of civilization are equally great, but in contrast to radiation the effects are insidious, slow and undramatic. It is for this reason that, as you suggest, a central agency whose sole duty would be the study of pollution in general would serve a very useful purpose.

With best wishes for the success of your bill, I am

Sincerely,

JOHN H. NORTHROP.

HUGHES AIRCRAFT CO.,
Culver City, Calif., November 21, 1967.

Hon. JOHN V. TUNNEY,
38th District, California,
Longworth House Office Building,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: I have read with interest and approval the print of HR 13211 which you provided, and your speech of September 27, 1967, which introduced the measure to Congress. I endorse the principal thrust of your proposal and will be interested to observe its progress.

In your letter of November 3, you request comments and reactions to the proposal. I have a few observations, as follows:

1. The wording of HR 13211 emphasizes the role of advice and counseling to the Executive Office by the Council, with no mention of the possible advocacy of legislative proposals. However, I judge it probable that legislation will eventually be required on some ecological questions where present jurisdiction, in the public interest, is either non-existent or imprecisely distributed among several executive agencies or departments. The Council should be authorized to submit to the President, for his consideration and possible forwarding to the Congress, legislative proposals upon any matter directly pertinent to the achievement and maintenance of appropriate environmental quality.

2. It is unfortunate that HR 13211 specifically identifies "sonic booms" as the only example of environmental noise. I do not regret or oppose public interest in the matter of sonic booms, but I do think it undesirable to highlight them as a particular villain. The Bill would be improved by the deletion of the parenthesis on lines 8 and 9 of page 3.

3. Finally, I would suggest to you that the performance of the Council would be enhanced if it had the participation of some of the agencies and departments whose views it must know, understand, and consider, and which the Council must hope to influence. I suggest that the Council be authorized to summon pertinent testimony, documentation, and proposals from any agency of the Federal Government directly concerned with the environment.

Sincerely yours,

ALLEN E. PUCKETT.

LITTON SYSTEMS,
Minneapolis, Minn., November 22, 1967.

Hon. JOHN V. TUNNEY,
U.S. House of Representatives,
Washington, D.C.

DEAR SIR: The October 1967 issue of *Environmental Science and Technology* makes mention of H.R. 13211 ("The Ecological Advisors Act of 1967"), which you recently introduced in the House of Representatives.

I am in complete agreement with this proposed legislation, since I firmly believe that a comprehensive ecological approach, one stressing cost/benefit as well as cost/effectiveness, represents the only intelligent response to our total environmental problem. Furthermore, our organization has a definite interest in contributing to national programs relating to ecological monitoring, analysis, control and management.

I would appreciate receiving a copy of your bill and being placed on your mailing list for information relating to hearings held on this topic.

Very truly yours,

ROY E. PETERSON,
Manager, Advanced Systems Programs.

GENERAL ELECTRIC CO.,
Philadelphia, Pa., November 27, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Congress of the United States,
Washington, D.C.

DEAR MR. TUNNEY: This relates to your invitation to comment on HR 13211, the "Ecological Advisors Act of 1967."

I believe the concept of total ecological planning is most timely. As you probably are aware, we are due for some serious re-thinking on the nature and consequences of our scientific and technical activities. This is due to an explosive increase in knowledge and capabilities to influence and change the ecology of the planet. When we can rationally think of weather modifications on a continental scale, when intercontinental aircraft speeds become of the same magnitude as the speed of the sun, when exploration of the radiation belts surrounding the earth induces permanent alteration of these belts, then, indeed, the capabilities and projections of science and technology become an appropriate concern for national policy review.

I believe that technical solutions can be found to the problems of air pollution, water pollution, solid waste, atmospheric radiation, environmental noise, etc., and I believe that a council of ecological advisors could make a major contribution in outlining the major concerns and stimulate solutions to these problems. I would think that existing bodies dealing with science and technology and their impact from a technical point of view, such as the National Academy of Sciences, the National Academy of Engineering, and the President's Scientific Advisory Committee and other similar bodies would have major contributions to make.

I, therefore, think the Bill is most appropriate at this time and I am wholehearted in favor of it.

Sincerely yours,

LEO STEG,
Manager, Space Sciences Laboratory.

STATE OF COLORADO DEPARTMENT OF PUBLIC HEALTH,
Denver, Colo., November 29, 1967.

Hon. JOHN V. TUNNEY,
Member of Congress,
Longworth House Office Building,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: I hope you will pardon my delay in replying to your letter of October 25 relative to the "Ecological Advisors Act of 1967."

At first thought it would appear to be a mistake to add yet another echelon of federal government to the already overly complex structure; however, on further study of your proposal the creation of such an Ecological Council seems to have a great deal of merit. I think you are correct in your assumption that such a Council could eliminate much duplication in the study of environmental problems and by proper coordination expedite the solution of some of the problems affecting the environment. Hopefully some of the fragmentation of programs such as those pertaining to water pollution, radiological health and pesticide hazards could be corrected. Such a Council could study the entire environment and make recommendations to the President; the Congress; and administrative agencies on needs and activities. We feel it is important that the Council itself not become involved in administration of the actual programs but serve entirely as a study and advisory group.

If you have not done so, I wish to suggest that you send a copy of the Bill to Dr. John H. Venable, President of the Association of State and Territorial Health Officers, Georgia State Department of Health, Atlanta, Georgia, and ask for an opinion of the Executive Committee of this organization. I think you should also seek the opinion of the American Public Health Association and the American Medical Association.

I am taking the liberty of sending a copy of your letter and my reply to the Honorable John A. Love, Governor of Colorado, and to the Colorado members of the U.S. House of Representatives.

Sincerely,

ROY L. CLEERE, M.D., M.P.H.,
Director of Public Health.

UNIVERSITY OF CALIFORNIA, LOS ANGELES,
Los Angeles, Calif., November 30, 1967.

Mr. JOHN V. TUNNEY,
Congressman, 38th District, California,
Longworth House Office Building,
Washington, D.C.

DEAR MR. TUNNEY: I was pleased to receive your recent letter, and to learn of your proposed legislation regarding environmental quality control.

The arguments you present for creation of a Council responsible to the President are cogent and pursuasive. The problems and concerns touch many agencies of the government and facets of our society.

You will find strong support for your proposal among many individuals and organizations concerned with the deterioration of our environment and its effects on health and on quality of life. A minor question concerns whether the designation as a Council of Ecological Advisors would adequately convey to the public the aims and goals of such a group. From the proposed legislation, it is clear that the interests are principally directed towards the impact of environmental deterioration on man, and one wonders if the advisors might be designated something as a council of advisors on the human environment.

Again, I would like to emphasize the need for a program such as you have mentioned and to voice appreciation for your thoughtful leadership in the area. Our society needs means of bringing problems, their possible solutions, and their long range implications clearly into focus for discussion and action. I hope you are successful in bringing your proposed legislation to fruition.

Very truly yours,

P. D. BOYER,
Director, Molecular Biology Institute.

JET PROPULSION LABORATORY,
Pasadena, Calif., December 4, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Longworth House Office Building,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: The matter of environmental control with which you have concerned yourself in HR 13211 is unquestionably one of vital and immediate concern. If we and following generations are to continue to utilize the national resources for industrial, agricultural, domestic and recreational purposes, and if we are to do this in a manner which will enrich our lives as citizens, we must take the appropriate steps to prevent degradation and wasteful exploitation of our environment. There are legal and technical means today to prevent the most gross fouling and pollution of the nations resources, but there are almost no mechanisms to anticipate or control the more subtle, but equally wasteful effects from interaction within an ecosystem. Even where individuals and organizations foresee adverse consequences for their locale, they find no mechanism to deal with their problem on a regional basis—the only basis which encompasses all the detriments. Thus, there is a need to provide local authorities and advisory bodies with scientific and technical information to support their efforts in developing and maintaining a clean, healthful environment for use and enjoyment of their citizens. This legislation is the necessary first step. The problems I see are threefold: one of education, one of organization, one of authority.

Ecology, while a familiar concept to scholars, is not a household word. It correctly identifies the scientific discipline which deals with environmental problems towards which this legislation is directed, but the public is generally not aware of the strong interactions and secondary influence of the various elements that create an ecosystem.

This should not detract from the wisdom of an educated legislature examining the problems and finding solutions. I point this out to direct your attention to the need for public information in this area. Exologists, like rocket scientists prior to the passing of the Space Act that created NASA, understand their particular problems but in isolation from the public. Regrettably, the strongest motivation for public attention is a national crisis. It is fortunate, of course, that we have not yet had an environmental crisis. In fact, we may never have an environmental crisis with impact comparable to Sputnik I. It is in the nature of environmental decay that the healthy state is lost in relatively small bits and pieces until the damage comes to public attention after it outweighs our capacity for corrective action. This complicates the task of arousing the general state of public complacency before the national need is even more acute. Perhaps, then, one of the major jobs of the Committee would be to assess the methods of public education in this area.

A second concern is one of organization. The nine-man council your bill proposes should avoid the problem of communications which frequently plagues councils with too many members and results in less productivity. The only problems I see with the council are recruitment and selection, finding the proper leadership, obtaining the strong commitment of time and energy from members, and providing a strong supporting staff. We have in NASA a similar high level planning board, the Lunar and Planetary Missions Board. We were fortunate in getting some of the richest scientific talent in the country. Many of these individuals have had past association with the space programs and so identification was not a great difficulty. Locating appropriate individuals for the Council of Ecological Advisors may be more difficult since they may require an even broader scope than the space scientists. Solely to understand their duties the members will deal with environmental problems which touch upon meteorology, marine biology, biochemistry, geography, forestry, soil science, and more, for this is the fabric of which ecology is made. Furthermore, relating ecology to man's welfare involves engineering, economic, community planning, health sciences, psychology, etc. The nation has spent a great deal of time, effort, and money to train our engineers and scientists in the inter-disciplinary specialties needed for the space program. Undoubtedly there will emerge a new breed of scientist who is some hybrid between classical ecologist, practical engineer, and waste disposal administrator.

Among the duties posed for the Council of Ecological Advisors is to "seek long-range solutions to environmental and ecological problems created by both man and nature." This implies to me capabilities and resources which would not appear to be available to the Council itself. It should be within the resources of the Council to identify such problems, but the solutions, as you emphasized in your speech before the House of Representatives on 27 September 1967, rest on an understanding of the environment which we do not yet entirely possess. The necessary scientific appreciation of the full scope of environmental interaction must be gained within an institution or institutions which have laboratory research capabilities and the means to test proposed solutions to specific problems.

The last problem I see is one of authority. My concern is that the Council while having the responsibility for reporting, advising, coordinating, promoting and gathering information, will feel the need for some authority. I realize this is an executive affair and that this bill may be only a first step in the long road of legislative corrective measures to restore and preserve the national environmental resources. However, it is probably not too early to consider how a next step can be taken to provide the necessary authority.

Whatever the scope of authority, I believe the actual results of the Council will be more of prevention than correction. Once a practice has been established, it is most difficult to reverse. On the other hand, we are certainly headed for some new ecological problems that can be rectified if we can understand them and act upon this knowledge. What will be the secondary and tertiary environmental and economic results of the large-scale uses of herbicides, the changes in salinity of fresh water likes, the removal of stand of timbers, heating of stream waters? The secondary and tertiary effects alone will be significant. Locating these new relations before they become problems and suggesting solutions is likely to be the most effective activity of the Council. The emphasis must be on inter-relationship among many aspects of the environment. Only with such an emphasis will adequate knowledge and adequate planning be mustered to solve ecological problems. Without such breadth of view, new solutions may only beget new problems: a roadway to solve transportation problems can endanger irrigation water from a watershed, which in turn may alter pesticide use, which in its turn disrupts recreational use of lakes and streams, followed by loss of property values and tax loss leading perhaps to federal monies being used for relief programs, etc., in a cascade of costly pallatives when planning could have secured mutual benefit for transportation, agriculture, recreation, real estate, etc.

Clearly, we cannot continue to ignore our nation's ecological problems, when misunderstanding or lack of understanding, poor planning or lack of planning costs money and reduces the quality and potential enjoyment of life; when costs of cleanup, emergency relief, tax support of abnormally high maintenance, and loss of revenue from water use, soil depletion, and mineral wastes continue to extract an unnecessary toll.

One way that the council could bring into focus the magnitude of the problem is to assess the financial loss from environmental neglect. This could be useful to emphasize the real economic loss and to muster aid in enforcing the current laws, while equally important, providing a basis for evaluating various measures of control and prevention. Figures frequently appear on the costs to the public of air pollution and water pollution but to my knowledge there is no agency that is responsible for the official set of figures supporting the broad basis of economic loss resulting from unplanned interaction with the natural environment.

In spite of this somewhat lengthy reply, I am by no means an expert in this area. I hope, however, that the foregoing will prove to be of some small assistance to you and, in any event, I want to thank you for your interest in my opinion.

Sincerely,

W. H. Pickering,
Director.

NEW YORK UNIVERSITY MEDICAL CENTER,
New York, N.Y., December 5, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Washington, D.C.

MY DEAR MR. TUNNEY: I have received your letter, copy of H.R. 13211, and the speech you gave in the Congressional Record bearing on this matter.

I have, on several occasions, with the Spillhouse Committee Report, Federal Council of Technology and the Linten Committee, urged the desirability of having, at the Presidential level, an advisory council for general oversight on a national basis of Federal concerns in the area of environmental pollution.

Your proposed council of "Ecological Advisers" goes directly to this point; the need is real and urgent. We have already lost a number of battles in fighting environmental pollution and will lose still more, unless some such mechanism is devised. In my view, there are two major circumstances which make such a group imperative. Responsibility for the maintenance of environmental quality cannot be fragmented according to (1) the geography of political subdivisions, or (2) the specific responsibilities of separate Federal agencies. These problems, almost without exception, cross both political boundaries on the one hand, and departmental divisions on the other. The council should be in a position to minimize difficulties arising from these two major handicaps. In addition, as you very eloquently suggest, the council is badly needed to provide a group in which an adequately long view of national needs is maintained.

In many instances, major projects cross departmental lines involving, for example, the Departments of Health, Education and Welfare, Agriculture, Interior, Housing and Urban Development or Transportation. Such projects present many difficulties in the absence of a mechanism for developing a shared responsibility for participation and funding. This is particularly true in projects relating to the environment in which the transition from a healthy man to a healthy environment is by no means sharp but gradual with much overlapping. A group, such as you suggest, could provide a high-level body for the assuring of shared participation in such major projects.

There is one comment that I would like to make. In your talk, you say "membership should be composed of social scientists, social and community planners, and public administrators." This omits the use of scientific expertise and technical background in the fields that are vital to this council. I think this is a serious mistake. By all means, persons with such backgrounds should be drawn on, however, the council must have in its membership individuals with scientific competence in the area of concern.

I thank you for the opportunity to comment on this important bill.

I am,

Sincerely yours,

NORTON NELSON,
Professor and Chairman.

SETAUKET, N.Y., *December 5, 1967.*

Hon. JOHN V. TUNNEY,
Congress of the United States,
House of Representatives,
Washington, D.C.

DEAR MR. TUNNEY: Thank you for your letter of November 2nd, in which you ask me to comment on HR 13211. This I am pleased to do, although my comments of course reflect my personal opinion and not necessarily those of either the Brookhaven National Laboratory nor the Atomic Energy Commission.

The objective of the bill is quite worthwhile, that of providing technical advice on Ecology to the President. It is of considerable importance then that the members of the council be professionally qualified to provide such competent technical advice, and certainly they should not be appoint simply on the basis that they might referee various uses of environment among competing interests. The question is large indeed, and one wonders if a part time board can do the job adequately in the face of current needs. It might be worthwhile to have a small permanent staff with perhaps one professional ecologist, a member of the board, in charge. The remainder of the board might be drawn from among professionally qualified scientists, representative of ecologists in related disciplines. The objective of the bill is commendable and timely, and I hope that a somewhat more specific version can be enacted.

Sincerely yours,

VICTOR P. BOND, M.D.,
Associate Director, Brookhaven National Laboratory.

THE FRANKLIN INSTITUTE,
Philadelphia, Pa., December 6, 1967.

Hon. JOHN V. TUNNEY,
House of Representatives,
Washington, D.C.

DEAR CONGRESSMAN TUNNEY: Of course I have long had an interest in ecological problems because of my own work in oceanography, and these for me have been intertwined with a concern for the proper utilization of natural resources. The intimate relationship was pinpointed for me when I served on a Committee of the National Academy some years back which, at the instigation of President Kennedy, took a comprehensive look at resources. During this work I become aware of two startling things: (1) that what we call waste itself is a potential resource, and (2) that our natural environment is a God given resource which no scientist or engineer can replace or reinvent if we destroy it. It was this kind of thinking that led to the tenor of the National Academy report, which I chaired, called "Waste Management and Control." This is a preamble to the comments that follow on your Bill H.R. 13211.

I was greatly cheered by the imaginative and comprehensive approach of H.R. 13211, the "Ecological Advisers Act of 1967," and yet, although you seem to focus with precision on the many environmental problems which the Federal Government should now address in a coordinated manner, your proposed solution—in my opinion—still suffers from excessive modesty! What we need is not only a Council of Ecological Advisors: we need a "National Resource Council" with stature comparable to the present National Security Council.

The National Security Council now provides the President with a mechanism for multi-agency coordination and follow-through in matters concerning national security and international relations. But the same kind of coordination vehicle, while often needed, is not now available in matters relating to the national welfare and domestic economic and environment planning. At one time we had a National Resources Planning Board. But, created under the National Security Act of 1947, it was related to the NSC structure and designed to address chiefly national-security questions and problems such as stockpiling, commodity (export) controls, etc. The NSRB was abolished in 1953 and its national-security functions were appropriately transferred to the then newly-created ODM, and successively absorbed into OCDM (1958) and the present OEP (1961). And I do not question that these particular responsibilities should not largely continue to be discharged there.

But the National Resource Council I envisage would help the President perform his total domestic responsibilities in an effective, and newly comprehensive, manner. The Council would deal with questions concerning natural resources, production economics, and uses and applications of these national resources. The new Council could operate much as the present NSC structure; now-existing bodies such as the Council of Economic Advisors could become part of the National Resource Council structure. In actual operation, economic questions, for example, could be dealt with in an NRC subcommittee with a membership representing the CEA, and the Treasury, Commerce, and Agriculture Departments and the Federal Reserve participating on an invitational basis. If environmental problems such as pollution or resource preservation demand attention, a subcommittee representing the Interior (or National-Resource), Agriculture, and Commerce Departments can be convened. And when environmental-social problems come up, say urban-population problems or solving a multifaceted transportation problem, there would be a ready-made context in which high-level task forces could readily be empanelled with the appropriate interdepartmental mix.

The proposed National Resource Council could rally State and local governments and the private sector in a most effective effort at "creative federalism." The Council would provide a more permanent, more continuously integrated, and more timely and responsive context in which to deal with critical national issues. And I do believe that *an ecological subcommittee, or advisory council or task force*, would be an essential element in the proposed NRC structure.

I hope, Sir, that you will forgive this expansive reaction to your excellent initiative. If you find the above ideas useful, either in addition to, or expansion of, your current proposal, please feel free to call on me for more detailed suggestions and support.

Sincerely yours,

ATHELSTAN SPILHAUS,
President.

National Laboratory on Early Childhood Education,
University of Illinois,
Urbana, Ill., December 10, 1968.

Hon. John V. Tunney,
Member of Congress,
House of Representatives,
Washington, D.C.

Dear Congressman Tunney: Thank you for your letter of 3 November which, because it was addressed to me at the University of Illinois in Este Park, Colorado, traveled about a bit before it arrived. Moreover, a case of bronchitis has delayed my answer longer than I would like.

First of all, as a citizen and also as a behavioral scientist, I am delighted with the basic intent of the bill (H.R. 13211). No one could agree more with your view that our society, "Must take a creative and comprehensive look at the ecology of our environment, concerning itself not only with the physical implications of the environment, but with the psychological and social implications of the conditions and interactions of the ecology of the environment on man." The idea of establishing a "Council of Ecological Advisors in the Executive Office of the President" is, I believe, entirely sound. I agree that it is exceedingly important that the larger part of the Council membership be composed of behavioral and social scientists, social and community planners, and public administrators. I believe the Council should also include biological and medical scientists. Although these are not explicitly mentioned, I am confident that you meant them to be included, for many of the effects of such ecological conditions as "air pollution, water pollution, solid wastes, atmospheric radiation, and environmental noise" operate at least partially through physiological and biosocial mechanisms.

One problem concerns the definition of "the problems of the ecology of the natural environment." Lines 6, 7, 8 and 9 of page 3 of HR 13211 give illustrations which tend to focus entirely on the physical aspects of the environment. The population problem is another ecological condition important for our day. Moreover, the social ecology of the ghettos and of the slums of our inner cities are exceedingly important as causes of poverty and of incompetence. I am taking the liberty of enclosing a copy of one of my own papers entitled TOWARD THE PREVENTION OF INCOMPETENCE. Pages 13, 14 and 15 describe very briefly some of the social ecological conditions which foster incompetence and the poverty which follows. The pages following page 15 describe a tentative prescription which the Office of Economic Opportunity has been authorized to try out. My main point here, however, concerns simply the matter of definition. Should you not include the problem of population and the social conditions of poverty along with those of air pollution, water pollutin, solid wastes, atmospheric radiation, and environmental noise, etc. if our society is to take the comprehensive view that you recommend in your splendid address to the House of Representatives?

Again, let me express my considered enthusiasm for the "Ecological Advisors Act of 1967." I hope your bill passes the Congress promptly.

Sincerely yours,

J. McV. Hunt.

APPENDIX D

LIBRARY OF CONGRESS ADVISORY OPINION

BACKGROUND

When Dr. John T. Middleton, Director, National Center for Air Pollution Control, Department of Health, Education, and Welfare testified before the subcommittee on January 18, 1968, there was considerable discussion concerning whether the Department had the authority under the Clean Air Act to prohibit automobile traffic in a city such as New York City.

Dr. Middleton had testified that the "motor vehicle is the largest single source of pollution throughout the Nation; perhaps 75 percent". The question arose, therefore, that if motor vehicles caused 75 percent of the pollution, could the Department stop motor vehicle traffic under section 108(k) to lessen somewhat the damage caused during an episodic event such as the Thanksgiving Day inversion in New York City in 1966.

Section 108(k) of the Clean Air Act of 1967* provides:

> (k) Notwithstanding any other provision of this section, the Secretary, upon receipt of evidence that a particular pollution source or combination of sources (including moving sources) is presenting an imminent and substantial endangerment to the health of persons, and finding that appropriate State or local authorities have not acted to abate such sources, may request the Attorney General to bring suit on behalf of the United States in the appropriate United States district court to immediately enjoin any contributor to the alleged pollution to stop the emission of contaminants causing such pollution or to take such other action as may be necessary.

When asked if a class action could be maintained under section 108 (k), Dr. Middleton replied:

> . . . I am sure you recognize this is a matter of considerable debate in the General Counsel's Office of the Department as well as in the Department of Justice. We are hopeful that the opinion will suggest we move against classes rather than individuals.

Following the hearings, the Subcommittee requested an advisory opinion from the Legislative Reference Service of the Library of Congress. Their conclusion, as indicated by the following opinion, is that a class action could not be maintained against automobile drivers, but that it could perhaps be maintained against a smaller class such as utilities or a type of industry.

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*Public Law 90–148, 81 Stat. 497.

Consequently, since it would be impractical to obtain personal service of process upon every motor vehicle driver, it would appear that, based upon the opinion, the Department would not have the authority to stop motor vehicle traffic.

As these hearings went to press, the Department's opinion was not available, nor did the Department have any comment on the opinion of the Library of Congress.

(The Library's opinion follows:)

THE LIBRARY OF CONGRESS,
LEGISLATIVE REFERENCE SERVICE,
Washington, D.C., April 18, 1968.

To: House Committee on Science and Astronautics
Attention: Mr. Joseph M. Felton, Counsel.
From: American Law Division.
Subject: Competence of HEW, proceeding under § 108(k) of the Air Quality Act of 1967 (81 Stat. 485, 497) to combat air pollution in a municipality attributable to (a) automobile traffic or to (b) industrial operations by instituting a class action against (a) automobile drivers or (b) against manufacturers or utilities with a view to enjoining operation of motor vehicles or the emission of pollutants by a class of industries such as public utilities or manufacturers.

I

Class action against motorists

Inasmuch as Rule 23 of the Federal Rules of Civil Procedure (28 U.S.C. Rule 23) governing class actions was substantially modified as recently as February 28, 1966, and the revision thereof did not become operative until July 1966, the interval of time which has elapsed since the latter date has not been sufficient to permit an accumulation of recent precedents numerous enough to present an accurate assessment of the significance of the aforementioned amendments. For these reasons it is not possible to advance a definitive conclusion as to whether these modifications effect such a liberalization of Rule 23 as to eliminate what are deemed to be obstacles to the institution of a class action by HEW against motor vehicle operators.

Reasoning by analogy from factually irrelevant precedents embracing plaintiff-defendant representatives of classes such as members of labor unions, corporate stockholders or bondholders, debtors, creditors, merchants and manufacturers affiliated with a trade association, or professional men or tradesmen conspiring with manufacturers to violate the antitrust laws, and, more particularly from evaluations thereof in legal periodicals, one is persuaded to assign the following reasons in support of the contention that a class action is not maintainable against operators of motor vehicles. The latter are too disparate and unidentifiable a group to merit description as a class whose members are bound together by a substantial common interest. Unlike the groups heretofore mentioned as plaintiff-defendant representatives of a class, operators of motor cars, busses, and trucks are not affiliates of a membership association such as the A.A.A. (Automobile Association of America); nor do they share any interest in property or claims to property.

Rather they are more nearly akin to taxpayers whom the late George Wharton Pepper described as "perforce, fellow-travellers and their association is essentially a corporation; but the bond of association between them belongs in the field of political science rather than in that area of voluntary economic or social effort. They have not joined a lodge or joined the church; and, in their capacity as taxpayers, they think of themselves, not as associates, but merely as victims of a common misfortune . . . Where there is a ready-made bond of association, it is relatively easy to apply the principle of volunteer representation. Stockholders are already committed to the representative function of elected directors; it is a short step, in an emergency, to substitute a volunteer. So in the case of a membership corporation—a church, for example, or a fraternal organization . . . The 'process' that is due . . . [taxpayers] may therefore easily be thought to be a much more individual process than otherwise would suffice" (quoted by Arthur John Keefe, Stanley M. Levy, and Richard P. Donovan. Lee Defeats Ben Hur. 33 Corn. L. Q. 327 350 (1948)).

In accord are commentators who assert that "some type of association or interaction among members of the class before the institution of the action would prove a greater likelihood that the members consider themselves and have consented to be treated as a class than would be the case when the class arises from the acts involved in the litigation. For example, the court should be less hesitant in binding a class when it is composed of members of a union suing for back pay than when the class is composed of a number of individual shippers suing for the loss of their cargo" (Multiparty Litigation in the Federal Courts. 71 Harv. L. Rev. 874, 937 (1958)).

Also militating against HEW's prospects of successfully instituting its contemplated action are a number of due process issues. Included among the latter is the problem of adequate representation. "The question of adequate representation is very important in a class suit; for there . . . a judgment binds all members of the class and adequate representation is essential to due process of law . . . In an action against a defendant class the court should be particularly careful to ascertain that the defendants named by the plaintiff have the necessary interest or the inclination to make a vigorous defense of the suit" (3A *Moore's Federal Practice* (2d ed., 1967) § 23.07 at pp. 3425, 3432); Federal Class Actions, 46 Colum. L. Rev. 818, 828–833 (1946)). "The number of representatives and the extent of their interests, if grossly disproportionate to the number in the class, . . . should also be considered by the court in determining whether the representation is adequate. Such determinations are especially important when the class is the defendant because the representatives of the class are probably chosen by the plaintiff with a view to their weakness and lack of incentive to present an adequate defense" (Multiparty Litigation in the Federal Courts, op. cit., p. 938; *Pelelas* v. *Caterpillar Tractor Co.*, 113 F. (2d) 629, 632 (1940); *Weeks* v. *Bareco Oil Co.*, 125 F. (2d) 84, 91–94 (1941)).

Inasmuch as the number of vehicles to be affected by litigation to suspend automotive traffic in a large metropolitan center on a given day is of staggering proportions, and in view of the absence of a common bond of affiliation among the operators of automobiles or of any agency capable of representing or speaking in their behalf, it would appear that the "representative parties" to be joined such as "will fairly and adequately protect the interests of [the aforesaid] class" of motor vehicle operators must be substantially in excess of the number conventionally joined in class actions. Fulfillment of this requirement, however, may be self-defeating; for it conceivably might entail the joinder and service of process on so large a number of representative-defendants as to render conduct of the litigation infeasible. Also tending to contribute to a similar result is the prospect that efforts to expand the number of defendants joined for purposes of achieving more equitable representation will be negated by defaults on the part of many defendants unable or unwilling to afford the expense entailed by conscientious participation in the litigation.

Finally, inasmuch as absentee members of the class; that is, those who are not served with process and joined as party defendants to the action are intended to be bound by the decree resulting therefrom, it is important that all members of the class be identifiable for purposes of satisfying the requirements of due process. If there are absentee members who cannot be identified, manifestly the latter cannot be apprised of the pendency of the litigation and the judicial order arising therefrom; and to the extent that they remain unaware of such judicial proceedings, HEW, consistently with the requirements of due process, will be unable to subject them to contempt proceedings for disobeying the mandate of the court ordering a suspension of vehicular traffic in a metropolitan area on a given day. To the extent that their number proves not insubstantial, the unidentified operators of motor vehicles in said area accordingly cannot be dismissed as insignificant; for their existence would appear to have a bearing not only on the adequacy of representation issue heretofore considered, but also upon the efficacy of enforcement of the judicial decree enjoining vehicular movement within the municipality on a fixed date.

Any effort on the part of HEW or Government counsel acting on its behalf limited to culling from state rosters the names and addresses of licensed operators and registered owners of motor vehicles resident in the metropolitan area to be affected by the injunctive decree may be calculated to leave unidentified one or more of the following groups of licensed motor vehicle operators: (1) nonresident tourists, whether domiciled beyond the borders of said metropolitan area but within the state in which that area is located, or domiciled in another state; (2) operators, who are domiciled in the same state in which the affected municipality is situate but outside the limits of the latter, and who are authorized, either as members of the family of a registered owner, or as employees of a registered owner, or as lessees of an equipment leasing agency, all similarly domiciled, to use the vehicle throughout the state and who may be within the limits of the affected city on the day on which the injunctive decree becomes operative; and, finally, (3) out-of-state commuters operating vehicles within the affected municipality on the date fixed for cessation of automotive traffic. Perchance, operators within these enumerated categories, having been apprised by out door posters, newspaper dispatches, or by radio or television announcements of the pendency or actual issuance of the decree, may volunteer to comply therewith; but on the basis of established precedents, such casual modes of notification would appear to be inadequate for purposes of exacting obedience from such operators in a manner consistent with the requirements of due process. "Where a group names a person its representative, or an individual vindicates a corporate right secondarily—canons of due process are not offended by holding the class to the result of the suit, either on familiar agency principles or because the possibility of being so bound is incidental to participation in corporate enterprise. But a different problem arises when absent parties are bound by judgments incurred by others *who are merely similarly situated.* At that point efficacy collides with principles of due process" (Federal Class Actions, op. cit., p. 830; emphasis supplied; *Christopher* v. *Brusselback*, 302 U.S. 500, 503–505 (1938)).

It is not believed that the aforementioned assessment of the measure of due process protection required to be accorded unidentified members of the class joined as defendants in litigation is in conflict with the provisions of the revised Rule 23(b)(c)(2) which stipulates that in any class action, "where the court finds that the questions of law or fact common to the members of the class predominate over any questions affecting only individual members, . . . the court shall direct to the members of the class the best practical notice under the circumstances, including individual notice to all members who can be identified through reasonable effort." In two decisions construcing this new rule, federal courts, in one instance, approved notice by publication as an adequate means whereby representatives, instituting an action on behalf of several thousand taxpayers residing in a sanitary district, might notify absentees; whereas, in the second instance, also involving absent members of a class of plaintiffs, another federal court concluded the varied nature of the interests asserted on behalf of the latter required individual notice and that due process standards could not be satisfied by "free publicity" or "by paid advertisements in newspapers of national distribution" (*Eisen* v. *Carlisle & Jacqueline*, 41 F.R.D. 147, 151–152 (1966); *Booth* v. *General Dynamics Corporation*, 264 F. Supp. 465, 472 (1967)). For reasons previously assigned, members of a class, whose only common interest is deductible from the fact that they are "merely similarly situated", are believed to be entitled to a more generous measure of protection when sued as defendants than when instituting an action as plaintiffs.

II

A. Class action against manufacturers or utilities emitting pollutants

Absent any evidence that manufacturers or public utilities are bound together by common ties in the form of membership in a trade association or of corporate affiliations embracing a parent-subsidiary or holding company relationship, presumably a class action could be instituted against a group of utilities or a group of manufacturers only upon the basis that the latter were similarly situated; namely, that each group was engaging in a course of action which give rise to "questions of law or fact common to the members of the class" or group and that such "common questions of law or fact predominate over any questions affecting only individual members" (Rule 23(a)(b)(3)). For "common questions of law or fact" to predominate, the manufacturers or the utilities constituting the class sued as defendants apparently would have to be engaged in productive activities which emit like pollutants, the dispersion of which was attended by a like hazard to public health in a reasonably compact geographical area. Thus the manufacturers conceivably might be processors of chemicals or the utilities might be guilty of burning coal with a high sulphur content. As to the area in which the utilities or the manufactu conducted their operations, the expanse thereof might embrace a small state in its entirety, or a specific industrial area in a large state. or a metropolitan area straddling state lines such as the upper New Jersey-New York City—Long Island-lower Connecticut sector. By reason of the limitations imposed by the requirement of common questions of law or fact, a class action on a national scale could presumably not be instituted against all manufacturers or all utilities whose divergent processing activities emitted a host of different pollutants which in turn were productive of consequences which in varying degree endangered life. In short, to the extent that differences were discernible in the pollutants emitted and in the dangers to public health generated thereby, such disparities could not be depended upon to give rise to "common questions of law or fact."

B. Who would defend against such class action and how would notice be given?

Normally, in a class action against either utilities or manufacturers, the Government would select certain manufacturing or utility corporations as representative of their respective classes and would join such representatives as defendants by having process served upon them. The latter will respond by defending the action. As to other members of the same class sought to be bound by the outcome of such litigation due process requires that they be accorded notice of the pendency of the suit and of the decree rendered at the conclusion thereof. Suggestive of the manner in which notice may be accorded to absentee members of the class is the procedure observed in *United States* v. *American Optical Co.*, 97 F. Supp. 66 (1951). Therein, the United States joined as defendants 22 oculists out of a total of 2000 constituting members of the class sought to be enjoined for conspiring to violate the antitrust laws. The Government petitioned the District Court to permit the Antitrust Division of the Department of Justice to forward by registered mail, with return receipt requested, to the remaining 2000 oculists a copy of the order of the court, a copy of the complaint, a copy of the Government's petition to show cause, and a copy of the supporting affidavit but without the Government's exhibit.

Unlike the contemplated action against operators of motor vehicles, the public utilities or manufacturers doing business in a limited geographical area and comprising the class sought to be enjoined probably would not be an unwieldy group in terms of numbers. Moreover, each member of the class could be expected to possess resources adquate to enable it to retain counsel for purposes of actively intervening and participating in the conduct of the litigation. Unless such intervention would expand the number of defendants actively engaged in the prosecution of the class action to a point calculated to interfere with the efficient disposition of the litigation, the trial court, under Rule 24(b), in its discretion, is empowered to grant applications to intervene. As revised, Rule 23(c)(2) grants absentee members of a class a right to enter an appearance through counsel; but this privilege apparently is not to be equated with a right of active intervention. Under Rule 23(c)(2) an absentee member is also accorded the privilege, upon request, of being excluded from the class.

Norman J. Small,
Legislative Attorney.

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